Edited by RICHARD DUMBRILL & IRVING FINKEL

Prima la musica e poi le parole

Proceedings of the International Conference
of
Near Easten Archaeomusicology
ICONEA 2008
Held at the British Museum
December 4, 5 and 6, 2008

Foreword

Twenty years ago, in 1988, Irving and I were thinking about organizing a conference of Near Eastern archaeomusicology at the British Museum. About ten would have attended, perhaps a few more, and so we decided to wait until December 2008. Our call for papers attracted about forty scholars and fourteen of the given papers are published in the present volume. The conference hosted a daily audience from about ten countries. This exceeded our wildest expectations. In January 2009, a lunch-time lecture on the contribution of Babylonian music theory to Western music, at the Museum and part of the Babylon exhibition, attracted over one hundred. The subject is getting popular.

Archaeomusicology is the youngest of the archaeological sciences. It is also a complex one as it demands a fair knowledge of musicology, organology, philology, archaeology and of the related arts and techniques. Up to recent decades, the subject was mainly fed by philological, iconographical, and archaeological research of scholars having some interest in music but who were not, principally, musicologists. Reciprocally, some musicologists exercised their skills in that field. However, their deficiency in the other sciences worked against them.

Music was often confused with musicology. However, being a musician, no matter how gifted, does not make of one a musicologist, and especially not an archaeomusicologist and in some cases, this may even prove detrimental. When I first exchanged ideas with the late Oliver Gurney, it was in 1987, he was much surprised at my usage of the word 'archaeomusicology'. Ethnomusicology, however, was in usage, why not archaeomusicology - the Germans already used 'Musikarchäologie' and the French 'archéomusicologie'.

In June of 2008, I had the privilege to sit, as a jury member, for the defense of a doctoral thesis at the Sorbonne University, in Paris. The subject was archaeomusicology. The jury included Frédéric Billiet of the Sorbonne, mediaeval musicologist; Nele Ziegler, from the CNRS, assyriologist; Pascal Butterlin, Versailles, Mari archaeologist; Annie Bélis, CNRS, Greek archaeomusicologist and myself, Near Eastern archaeomusicologist. This was the first defense of a truly Near Eastern archaeomusicological thesis. The candidate was Myriam Marcetteau. We granted her the title of Doctor of the University with 'mention très bien', and unanimous congratulations from the jury. The science of near eastern archaeomusicology was crowned and truly recognised on that day.

ICONEA is the receptacle of Near Eastern archaeomusicological data, organiser of ICONEA conferences and publisher of the conference proceedings, both as a book form and online. Why online? Simply because it is our policy to contribute in reducing pollution and also because in this form music can be embedded and shared along with the traditional data. ARANE, the Archaeomusicological Review of the Ancient Near East is also an online and printed publication of ICONEA. It differs from the ICONEA volumes in that there is no academic censorship, within reason. All may add to it, at any time, and when there are enough papers, it goes to press, on demand. The ICONEA database: www.icobase.com is free for all and data is constantly added to it. All are welcome to post their comments and propose *addenda*, papers, and all that will contribute to its expansion. The access to the data is free but any financial contribution, however modest, will be greatly welcome as at present only a few of us pay for its maintenance.

ICONEA 2009 was held at the Sorbonne Paris IV, in November 25, 26 and 27. ICONEA 2010 will be held at the British Museum on December 9, 10 and 11.

Richard Dumbrill

Of all the extraordinary discoveries that are due to archaeology, the recovery of ancient music, or even an echo of it, must rank among the most wonderful. The ancient Middle Eastern world, once known only to us through the Bible and classical literature, has become increasingly accessible since the middle of the nineteenth century, thanks to fieldwork in the ancient sites and cities and the decipherment of the ancient languages and literatures of those times and regions.

Evidence for the music of ancient Mesopotamia in particular is now surprisingly rich, and the modern musicologist who is tempted to investigate this field will draw his conclusions from textual evidence in the form of cuneiform inscriptions on clay tablets, actual instruments that have emerged from the soil to be restored, reconstructed, tuned and played, as well as numerous images of instruments in use in various forms of art. In addition he is entitled to compare evidence from the surrounding world, contemporary and sometimes even much later, up to our own day. By assessing and combining all this elusive evidence, it is now possible to produce modern instruments after the model of their ancient counterparts, and by so doing present to a living audience some faint impression of the type of sounds once familiar to those long-dead people.

In recent times there has been a most fruitful revival of interest in this section of the history of music, with the steady recovery of new evidence to complement it. Thus this volume, the result of a conference of a great variety of interested scholars, presents the reader with an up-to-date summary of what is known of the music of ancient Mesopotamia and its environs, and speaks for itself on behalf of a deeply fascinating and increasingly informative aspect of the Humanities at large.

Irving Finkel

Editorial notice

Half of the papers published in the present volume have been written by scholars for whom the English language is not the mother tongue. Although the greatest care has been addressed in the general formatting of this volume, the responsibility for the editing of papers has rested in the hands of their authors. In order to avoid difficulties in translations experienced with the present volume, the next issue will publish papers originally written in English, French, German, Italian and Spanish.

The aim of ICONEA is to publish specialised papers of Near and Middle East archaeomusicology at the highest standard and will only accept contributions which reflect this level of excellence. However, students and enlightened amateurs will always be considered for publication and would be guided by senior members of the academic board of ICONEA.

ICONEA 2008

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In memoriam Subhi Anwar Rashid
1928-2010

Photagraph taken at the Cairo Conference, 2003.

POSSESSED BY THE GREAT MOTHER:
MUSIC AND TRANCE IN ANCIENT POMPEII AND IN THE POPULAR TRADITION OF SOUTHERN ITALY

Roberto Melini

In his *Ab urbe condita*,[1] Livy writes that owing to the unusual number of stones which had fallen from the skies during the year, the Sibylline Books had been consulted. Some oracular verses advised that should foreigners attempt to invade Italy, they could be driven out, and to do this, the *Mater Idaea* had to be brought from Pessinus to Rome. Thus, a famous black stone representing Cybele, the Great Mother, was carried from Anatolia to the capital. This was the year 204 B.C., and the detailed chronicle of the event, as Livy reconstructed it many years later, had become part of the new Roman religion. On top of the Palatine, a temple was erected for the goddess.[2] Feasts and celebrations were instituted for her cult. But the inclusion of an Oriental divinity in the pantheon which the people had inherited from their ancestors, was certainly not to the taste of all Romans. The senate even forbade its citizens to become part of her clergy, but in time her veneration became rooted in society to such an extent that the divine wind blowing from the East culturally affected every stratum of the population.

In the *Aeneid*,[3] Virgil placed her at the very origins of the godly lineage. The Great Mother stood in the *Cibèlo*. She lived there with the bronze cymbals of Coribantes, with the sacred wood of Ida and its arcane Mysteries, with two lions drawing her chariot. Music was present in all public celebrations in her honour, the most important of which being the *Ludi Megalenses*. This included the acting of cultual scenes,[4] enhanced by the practice of Mysteries. Cybele was represented as goddess of the tambourine. Her partner Attis was also often pictured in connection with music. In his *De errore profanarum religionum*,[5] Firmicus Maternus writes that the believers ate from the tambourine, and drank from the *kimbalon*. They had become mystes of Attis.

During special esoteric rituals then widespread in Roman society, such as rites for Dionysus, Sabatius, Mithras, and Serapis-Isis from Egypt, the initiated went through a phase during which they experienced some distortion of reality and subsequently entered into a trance. This was induced by a combination of foodstuffs, drinks and drugs, to which spiritual stimuli, such as sound, music and dance, were added. They lost consciousness and entered into a supernatural world. In his *Non posse*,[6] Plutarch writes that many thought initiation and purification for the people would be helpful as once purified they would believe that they could carry on playing and dancing in Hades, in splendorous places, of pure air and light.

These beliefs spread well beyond the walls of the city where secret orgies, sometimes subversive, took place. The practice arose in the provinces which had already experienced cultural exchanges with Mediterranean and Oriental civilisations such as the lands south of the Italic peninsula, the old Magna Graecia. There was much evidence of sects devoted to the cult of Dionysus-Bacchus, as seen on the Dyonisiac frescoes at the Villa dei Misteri, in Pompeii (fig. 1), even long after these practices had been officially banned in Rome.[7]

Fig. 1

Pompeii was dominated by the volcano. It had been a cradle of civilisation (the Greeks first landed in the island of Pithecousa, at the beginning of their colonising of the peninsula). The eruption of 79 A.D. buried much evidence of the intense cultural activities which had taken place there. The monuments of glory had disappeared. However, archaeology has yielded a wealth of materials which illuminated all aspects of daily life in Ancient Rome.

Researches in the practice of music allows for a comparative study of ancient rituals with those of modern times. Textual evidence from charred scrolls found in the Villa dei Papiri, in Herculaneum, has confirmed details of beliefs which had been described by Philodemus of Gadara.[8] He was a master among Epicureans. Additionally, archaeological finds from Southern Italy, such as some golden leaves with orphic inscriptions,[9] echo his philosophical theories on the existential value of music. Much of the iconography retrieved from the Vesuvian ashes, appears to have been inspired by cult ritual, and staged events where the magic power of sound is clearly attested. In a tangle of faiths and ideas, which sometimes seem inextricable, appear images of various beliefs. Dionysus-Bacchus and his followers, as seen on the fresco in the Casa di Lucretius Fronto, shows the triumphal arrival of the god surrounded by his '*thiasus*' (fig. 2) as cymbals and tambourines shaken by quivering hands are played everywhere on the beach.

Fig. 2

In his *Ars amatoria*,[10] Ovid writes that there were maenads with loose hair and nimble satyrs. There was a crowd preceding Bacchus, the God. There is evidence of strange objects, flaunted symbols of Sabatius, a magic vase (fig. 3), the '*pantea*' hand[11] and Isis, all along with the Great Mother.[12]

Cybele is at the heart of sound along with the musicians participating at her mysterious cults. She is often associated with the tambourine seen on the walls of Pompeii (fig. 4).[13] She is also represented on fictile terracottae (fig. 5). Attis too, recognizable with his Phrygian hat, is often seen playing the syrinx, an instrument which came from the Orient. Similar figurines were unearthed at Campania as well as in Taranto, in Reggio, and elsewhere (fig. 6).[14] In Pompeii the lifestyle which preceded the eruption would have allowed for widely practised religious syncretism. Much evidence is narrated on the great fresco on a façade at the Via dell'Abbondanza (fig. 7). There worshippers are about to carry a statue of the Great Mother in a procession.

Fig. 3

In his *De Rerum Natura*,[15] Lucretius says that she was adorned with the same elements. She is carried forth, solemnly, in many mighty lands. They are told to listen to the wide nations and their antique rites. They are asked to call for the Idaean Mother with her escort of Phrygian bands. Yet, if the goddess is sitting on her throne, dominating the scene, opposite her, in a small shrine, stands a bust of Dionysus. This well-worn representation shows a wealth of details. Some play the reed-pipes, others the cymbals and tambourine. They might have been *galli*-priests belonging to an exclusive caste portrayed on a funeral relief from Ostia.[16]

It is also recorded that on particular occasions their rituals would involve some violence. According to Lucretius,[17] when the *galli* arrived hollow cymbals, and tight-skinned tambourines were played along with the clapping of hands. Fierce horns threatened with their raucous bray, while tubular pipes were played in the Phrygian style. This would excite their maddened minds. They carried knives as well as disturbing emblems. This procedure added to the goddess's power brought panic and terror all around. Along with Cybele's ministers, who were active in the temple, the wandering-priests (*metragyrtes*) played tambourines, cymbals and reedpipes. They also begged on behalf of the goddess. Dioskourides of Samos depicted them on a famous mosaic in Pompeii (fig. 8). The scene is also repeated on paintings, notably from villas in Stabia alongside players of reed-pipes and tambourines.[18] They might have been monks who specialised in this ritual music (fig. 9).

Fig. 4

Fig. 5

Fig. 6

right where they were found. Recently, at the site of the Villa dei Papiri, in Herculaneum, a throne was excavated. It was made of wood and veneered with ivory. Among many objects adorning it was a pair of hanging cymbals (fig. 13).[21]

No actual tambourine has ever been found through archaeology, unsurprisingly, since they were mainly made of wood and leather. On the other hand, the literary and iconographic evidence for these instruments is so frequent that there is no doubt about their wide-spread usage (fig. 14).[22]

Fig. 7

Some of the iconography at Pompeii has caught female characters in a trance (fig. 10). They might have been maenads or perhaps matrones. It is difficult to say if this depicted reality or whether it reflects fertile imagination, but the obsessional and obstinate rhythm played along with the taking of drugs might have induced exaltation and hallucination among worshippers. Here, life and myth mingled together to the echo of both archaic and invented sounds. On all these representations the figures are seen dancing to their own accompaniment of wind and percussion instruments. Strings were excluded for ideological reasons as well as for practical ones as they would not have been loud enough to be heard in a crowd during the practice of noisy rituals. Idiophones belonged to the Great Mother. In particular, cymbals were played during the liturgy as representing both hemispheres of the heavens surrounding the earth, mother of the gods, as described with Servius.[19]

Close to Mount Vesuvius, several pairs of cast bronze cymbals were unearthed in good condition (fig. 11). In Pompeii, in the *praediae* of Julia Felix, another pair was found and (probably by pure coincidence), a similar pair is depicted in a scene on the walls along with other symbols of Dionysus (fig. 12).[20] While it might be far-fetched to assume that it had been used as a model by the artist, we can show that such cymbals were used there,

The playing of these tambourines is an interesting matter. The abundant evidence of its usage in the periphery of Mount Vesuvius, particularly, and of Southern Italy, generally, calls for our attention. The survival, to this day, of age-old socio-cultural practices must be observed in a larger cultural setting. Roberto De Simone, a well-known composer and ethnomusicologist, wrote, after a visit at the Archaeological Museum of Naples, that his particular experience - from the sixties and seventies - involved material from both peasant or pastoral worlds.[23]

As he has shown, the playing of specific instruments is still perpetrated in the Campania region in a similar fashion to the musical scenes painted on the ancient frescoes at Pompeii.

Fig. 8

Focusing specifically on the sacred, it is clear that very vivid popular practices arising in this region can be related to ancient cults. Furthermore, in the 19th century, Friedrich Nietzsche said that either through the influence of narcotic drinks, which is well referenced in popular hymns, or because of the powerful influence of Spring, the Dyonisian spirit arises, and as it intensifies, the subjective fades into complete forgetfulness of the self. During the Middle Ages in Germany, and under the same power of Dionysus, ever-growing hordes thronged from place to place, singing and dancing. St John's and StVitus' dances obviously stem from the Bacchic chorus of the Greeks, once again, with its forerunners deep-rooted in Asia Minor, right back the orgiastic *Sacaea*.[24]

Fig. 9

This inheritance is well documented, especially from a systematic survey on songs and dances of Southern Italy, in Campania, Calabria, Apulia and in Sicily where manifestations of trance and possession could be witnessed until recent times. Some of them could be traced right back to the cult of Cybele.
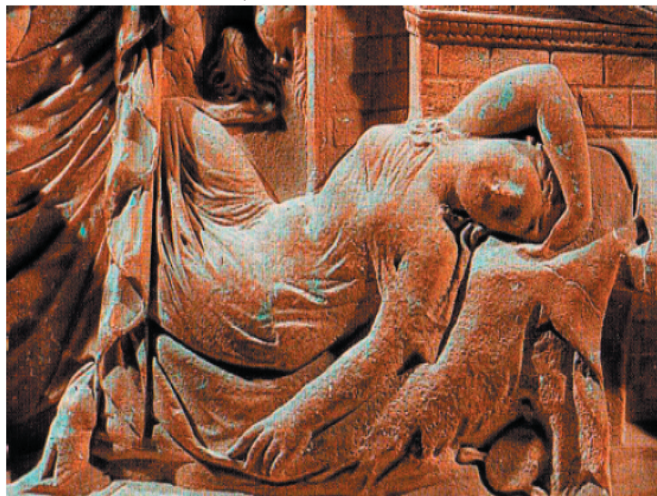
Fig. 10

In the early days of modern ethnomusicology, these phenomena have been scientifically investigated by many scholars, leading to some milestone publications. For instance, the American ethnomusicologist Alan Lomax travelled to Italy in 1954 in the company of Diego Carpitella. During his field work, he recorded over 3,000 pieces which were put out on acclaimed LPs (fig. 15).[25] In 1959, in the region of Salento, the anthropologist Ernesto De Martino, conducted research into the practice of '*tarantismo*' and published *La terra del rimorso*, 'The land of remorse', a work which spearheaded a series of studies on the subject.[26] During the following decades, the aforementioned Roberto De Simone researched the historico-mythological roots of musical expressions he gathered in the region of Campania. His legacy included volumes depicting popular and more sophisticated spiritual practices which coexisted in that region.[27]

However, such intriguing material can lead towards doubtful epistemological interpretation and needs rational evidence in its support. About '*tarantismo*', Ernesto De Martino had witnessed the persistence of the belief that physical and psychical consequences of the tarantula's bite could be cured with musical exorcism. Trances of that nature had already been investigated, at different levels, by more or less objective scholars since the Middle Ages,[28] but only the most modern researches, reconsidering the medico-physiological approach have succeeded in the interpretation of its mystico-symbolical meaning. In Galatina, which is a country town in the region of Salento, in Puglia, a peculiar event of devotion and thanksgiving involving people suffering the disease caused by true or alleged bites was still to be witnessed still in recent years.

Every year, on St Paul's Day,[29] June the 29th, the saint's chapel hosted scenes where believers reenacted awesome rituals (fig. 16). They thought that the sickness and apathy from which the victims suffered, often women from humble rural background, could be cured by specialised musicians, the '*paranza*', performing specific pieces. They were purposely recruited on that occasion.

Fig. 11

As a part of the liturgy, which also included symbols of water, of swings, of labyrinths and of specific colours, musicians played different melodies, carefully observing which one was more effective. When they agreed, the *tarantolata* ran riot in a frenzied dance (the *pizzica pizzica*) which mimically represented the possessed and, at the same time, the struggle to free from this possession. This, sometimes lasted days, in different stages, till exhaustion (fig. 17).

Fig. 12

During the ritual, the rhythm of the music was prominent. It was played by the tambourine which stood right at the heart of the music. It had become the typical symbol and heir to Cybele's own instrument, the *tympanum*. Euripides tells of the mythic invention of this instrument. He states that the cults of the Great Mother and of Dionysus were considered, even in classical Athens, as almost two aspects of the same creed:

Fig. 13

'O hidden cave of the Curetes!/O hallowed haunts in Crete, that saw Zeus born, where Corybantes with/crested helms devised for me in their grotto the rounded timbrel of/oxhide, mingling Bacchic minstrelsy with the shrill sweet accents/of the Phrygian flute, a gift bestowed by them on mother Rhea, to/add its crash of music to the Bacchantes' shouts of joy; but frantic /satyrs won it from the mother-goddess for their own, and added it/to their dances in festivals, which gladden the heart of Dionysus,/ each third recurrent year'.[30] In the South, nowadays, this instrument is known as the *tammorra* and has variations according to different regional cultures (such as, for example, with the dances of *tammorriata*, *pizzica* and *tarantella*...[31]), it keeps on creating pulsations which are the cause of joy, frenzy and sometimes mania (fig. 18).
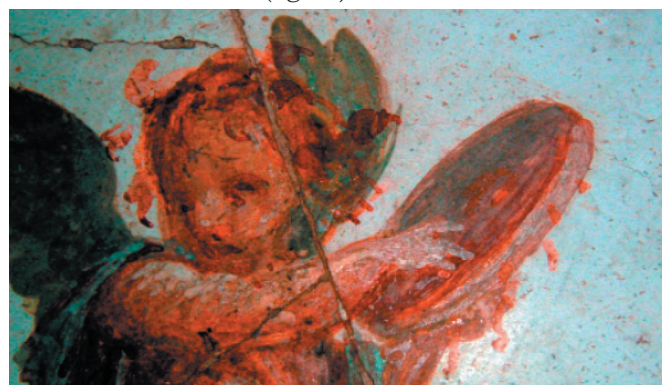
Fig. 14

The state of trance which arose from these frantic rhythms also took place in Barano d'Ischia (and survives today though perhaps more as an attraction for tourists). Every year, on Easter Monday and also on the occasion of St John the Baptist Day, on the 24th of June, the hamlet of Buonopane is the setting for the *'n'drezzata'* where it is performed.[32] Here too, the feast has been assimilated by Christianity from its pagan roots. The *'n'drezzata'* is a ceremonial dance where all the protagonists are males. In the case of couples, one male takes the role of a female (fig. 19). If the recent origin of this tradition can be traced back to blood feuds in the 16th century, even more remote roots can be located among other mythological sources[33] on account of the Greek presence on the island.
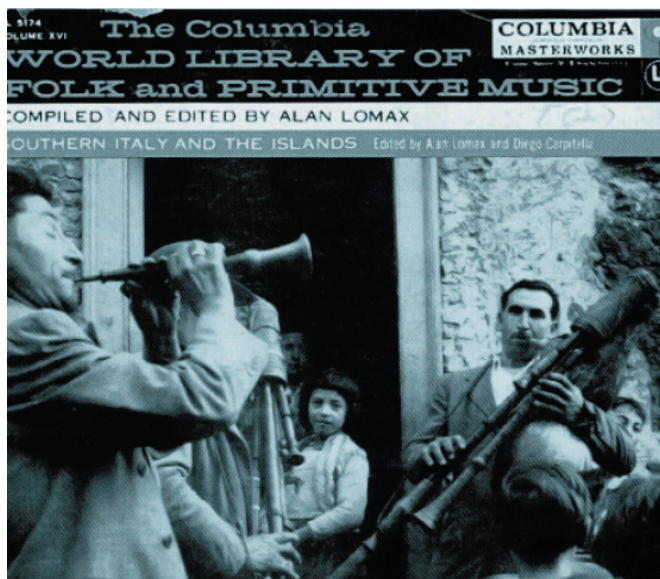
Fig. 15

In his controversial book, Marius Schneider investigated a dance which was performed by armed men simulating fighting (fig. 20).[34] This is reminiscent of Lucretius' description of Cybele's ministers: 'Here is an armed troop, which the Greeks/call Phrygians Curetes. Since/haply together they used to play/games of arms and leap in rhythm around/with bloody mirth and shaking/their terrorizing crests upon their heads...'[35]

Fig. 16   Fig. 17

In this myth, the function of the Corybantes was predominant as was reported by Diodoros:[36] 'Corybant named the Corybantes from his own name, and describes all of those falling into divine excitement during the celebration of the Mother's rites...'. In Ancient Rome, it was the *galloi*, the ministers of the cult, who took the place of the Corybantes, and there, as a consequence of the ritual, injuries and mutilations were sustained by the protagonists.

It is obvious that music was an essential component of the rite: '...they were all, possessed by fury, and like the Bacchantes, in an armed dance, between clamours and the noise of tambourines, the noise of the army, the sound of the *aulos* and shouts as the ritual goes on, spreading

fear in its course...'[37] This phenomenon is not unique to Southern Italy. There is also the 'dance of swords', which is staged in Torre Paduli, Peninsula Salentina, outside the sanctuary of St Rocco. It runs from sunset on the 15th of August to the following dawn. Here an ancient and symbolic fight ritual is revived in a kind of knife duel enacted by men dancing in pairs.

Fig. 18

The male/female ambiguity persists also in the rites performed at a Marian sanctuary, at the site of Montevergine, in Campania. On the day of the catholic feast of Candelora, the 2nd of February, believers leave for a pilgrimage climbing up the mountain. There is much singing of animated songs of devotion (fig. 21). The main actors for this event are called *femmenielli*, they are male homosexuals, who since time immemorial joined the procession leading to Montevergine. This was an occasion to express their devotion to the *Madonna Nera*, the Black Virgin.[38] Here too, musical and choreographic components are at the center of the ceremony: the whole procession is punctuated by the beats of the *tammorre*, and as the sounds reach their loudest, some worshippers may experience a feeling close to a trance (fig. 22).[39]

The ritual taking place at Montevergine is another example of a Christian rite stemming from pagan sources. The relation with Cybele firstly needs be investigated from the history of the site itself. It is said that a shrine was erected there where a temple dedicated to the cult of the Great Mother first stood. This has been corroborated with the evidence of archaeological finds.[40] Secondly, the presence of specific symbols makes the connection obvious: the particular usage of carts, for example, or the similarity with the homosexuality of modern believers and the lack of virility of the ancient worshippers (the priests of the goddess wore female clothes in observance of their theology, and emulating Attis, they even emasculated themselves: 'Go together, votaresses, to the high groves of Cybele./Go together, wandering herd of the lady of

Dindymus', 'emasculate your bodies from too much hatred of Venus'[42]), and above all, the meaning of the music.

Galatina, Barano d'Ischia, Montevergine are three examples of contemporary spirituality coming from past times (figs 23 and 24).

At the end of this path, cross-references between antiquity and the present, the mirroring of reality and myth, and the symbolic weaving of music and poetry, seem so intense that almost we do not understand to whom is directed the pressing call of Catullus:[43] 'Overcome your reluctance: together/go to the Phrygian shrine of Cybele, to her groves/where the voice of cymbals sounds, the tambourines rattle,/where the Phrygian piper plays the deep curved pipe,/where Maenads wearing the ivy throw back their heads,/where they practice the sacred rites with sharp yells./Where they flutter around the goddess's cohort:/it is there we must go with our rapid dances'.

Fig. 21

Fig. 19

Typus Tarantiacorum Saltantium.

Ballo d'Tarantella del Affeminati di Napoli.

Fig. 22

Fig. 20

Fig. 23

SACRA MATRI MAGNÆ IN ANTRO IDÆO.

Fig. 24

Notes

1 Livius, *Ab urbe condita*, XXIX 10, 14: 'Civitatem eo tempore repens religio invaserat invento carmine in libris Sibyllinis propter crebrius eo anno de caelo lapidatum inspectis, quandoque hostis alienigena terrae Italiae bellum intulisset eum pelli Italia vincique posse si mater Idaea a Pessinunte Romam advecta foret'.

2 The stone was temporarily housed in an ancient shrine, the *aedes victoriae*, until it was moved into a dedicated temple which was built in 191 BC.

3 Virgilius, *Aeneis*, III, 111-113: 'Hinc mater cultrix Cybeli Corybantiaque aera/Idaeumque nemus, hinc fida silentia sacris,/et iuncti currum dominae subiere leones'.

4 Plautus and Terence, among others, wrote comedies for these occasions.

5 Firmicus Maternus, *De errore profanarum religionum*, 18, 1: 'De tympano manducaui, de cymbalo bibi et religionis secreta perdidici...'.

6 Plutarch, *Non posse*, 1105b.

7 With the *Senatus consultum de bacchanalibus*, in 186 BC. (Livius, *Ab urbe condita*, XXXIX 18, 3).

8 The scroll *PHerc.* 1497, for example: discovered in 1752, it is the most important.

9 A golden leaf, from Thurii (Calabria), is preserved in the Archaeological State Museum of Naples, no. 1463.

10 Ovidius, *Ars amatoria*, I, 535-536 and 539-540: 'Sonuerunt cymbala toto/litore et attonita tympana pulsa manu'; 'Ecce, Mimallonides sparsis in terga capillis,/ecce, leves Satyri, praevia turba dei'.

11 Both from the *Casa dei Riti Magici* (*di Sestilius Pyrricus*, Pompeii II 1, 12), the fictile vase is exposed in the *Antiquarium* of Boscoreale, no. 10529, while the 'pantea hand' is preserved in the Archaeological State Museum of Naples, no. 10845.

12 In Pompeii, despite the absence of epigraphic evidence, the cult for the Great Mother is certainly attested. For instance, it seems that a single lump of black lava, embedded in a niche near the entrance of a thermopolium, was an allusion to the stone of Pessinus.

13 Wall painting: picture portraying Cybele as bronze statue, from Pompeii Casa VII 8, 28 (Archaeological State Museum of Naples, no. 8845).

14 For example the fictile figurine preserved in the Archaeological State Museum of Naples, no. 20313. All the archaeological evidence related to the cult was gathered by Maarten J. Vermaseren in the fundamental work *Corpus Cultus Cybelae Attidisque* (CCCA); the finds from Southern Italy are arranged in volumes IV *(Italia-Aliae provinciae)* and VII *(Musea et collectiones privatae)*.

15 Lucretius, *De rerum natura*, II, 610-3: 'Hanc variae gentes antiquo more sacrorum/Idaeam vocitant Matrem, Phrygiasque catervas/dant comites, quia primum ex illis finibus edunt/per terrarum orbem fruges coepisse creari'.

16 *Archigallus coloniae ostienis*: funerary bas-relief from the necropolis of Isola Sacra, in Ostia Antica (first half of the third century).

17 Lucretius, *De rerum natura*, II: 618-623: 'Tympana tenta tonant palmis et cymbala circum/concava, raucisonoque minantur cornua cantu,/et Phrygio stimulat numero cava tibia mentis,/telaque praeportant violenti signa furoris,/ingratos animos atque impia pectora volgi/conterrere metu quae possint numinae divae'.

18 They are exhibited in the Archaeological State Museum of Naples (no. 9034 and no. 20545).

19 Servius *apud* Virgilius, *Georgica* 4: 64.

20 These finds are preserved in the Archaeological State Museum of Naples, no. 10159 (the object) and no. 8795 (the painting).

21 These reliefs could be related to the *Attideia*, the celebrations in honor of Attis introduced by the emperor Claudius.

22 In the catalogue *Pitture e pavimenti di Pompei*, 120 paintings representing tambourines are quoted, but the number is approximated by defect. (Bragantini, I. de Vos M. and Parise Badoni F. (ed.) (1981-Roma) *Pitture e pavimenti di Pompei*.

23 De Simone, R. (1999-Milano) 'La musica nella Pompei romana' in *Homo faber, Natura, scienza e tecnica nell'antica Pompei*: 29.

24 Nietzche, F. (1872-Leipzig) *Die Geburt der Tragödie aus dem Geiste der Musik*: 'Auch im deutschen Mittelalter wälzten sich unter der gleichen dionysischen Gewalt immer wachsende Schaaren, singend und tanzend, von Ort zu Ort: in diesen Sanct-Johann- und Sanct- Veittänzern erkennen wir die bacchischen Chöre der Griechen wieder, mit ihrer Vorgeschichte in Klienasien, bis hin zu Babylon und den orgiastischen Sakäen. Es giebt Menschen, die, aus Mangel an Erfahrung oder aus Stumpfsinn, sich von solchen Erscheinungen wie von 'Volkskrankheiten', spöttisch oder bedauernd im Gefühl der eigenen Gesundheit abwenden: die Armen ahnen freilich nicht, wie leichenfarbig und gespenstisch eben diese ihre 'Gesundheit' sich ausnimmt, wenn an ihnen das glühende Leben dionysischer Schwärmer vorüberbraust'.

25 Parts of these valuable recordings were recently republished in the series 'Italian Treasury' of '*The Alan Lomax Collection*': the CD is entitled *Puglia: the Salento* (Rounder 82161-1805-2, Massachusetts 2002).

26 De Martino, E. (2002-Milano) *La terra del rimorso. Il Sud, tra religione e magia*.

27 De Simone, R. (1982-Napoli) *Canti e tradizioni popolari in Campania*; (1979-Roma) *Il segno di Virgilio*, etc.

28 The oldest text on this subject seems to be from a 16th century erudite (Corrado, Q. M. (1581-1582-Venice) *De copia latini sermonis*), but similar phenomena are told even in the chronicle of the First Crusade (Albertus Aquensis, *Historia Hierosolymitanae expeditionis*); later on, even the Jesuits, within the context of the baroque studies on the 'iatromusic', dealt with (Kircher, A. (1643-Köln) *Magnes sive de arte magnetica opus tripartitum*).

29 It is reported that during his stay in Malta, St Paul cured the effect of a bite and then when he landed in the Italic peninsula, he granted the same privilege to the land of Salento (see *Acts of the Apostles*, (XXVIII, 1-10).

30 Euripides, *Bacchae:* 123-34.

31 The revival of pizzica, for instance, has become a sort of emblem of Salento (the *Festival della Taranta*), with considerable repercussions on the cultural, social and economic-touristic plan.

32 The term refers to the braiding made by the movements of the musicians. The event is also called the 'mascarada', the mascarade.

33 There are different versions, involving Apollo, the Nymphs and also Aesculapius: his presence corroborates the thermal vocation, still important in the locality to this day.

34 Schneider, M. (1948-Instituto Español de Musicología) *La danza de espadas y la tarantela*. The dancers in the n'drezzata hold a short and sturdy stick (the 'mazza'), in one hand and a longer one, spear-like, in the other.

35 Lucretius, *De rerum natura*, II: 629-632: 'Hic armata manus, Curetas nomine Grai/quos memorant Phrygios, inter se forte quod armis/ludunt, in numerumque exultant sanguine laeti...'.

36 Diodoros, V 49: 3.

37 Strabo, *Geographia*, X: 3, 7.

38 The complex implications related to the name (Vergine = Virgin = parthenos), and to the figure of the Madonna Nera (Black Virgin), that here is called also Madonna Schiavona (Virgin of the slaves), are very significant.

39 Besides Montevergine, the music of the tammorra is the heart of several other religious events in Campania, for example in those of Somma Vesuviana, Scafati and Maiori.

40 The existence in this area of a sacred structure is attested right from the *Itinerarium Antonini Augusti* (2nd century); the humanist Flavius Biondo, in *Roma triunfans*, conjectures that a convent dedicated to the Virgin and placed, precisely, above the country town of Mercogliano was in antiquity a temple of Cybele; in 1649 Giacomo Giordano, in *Croniche di Monte Vergine*, writes that during the works at a sanctuary some objects connected to the pre-Christian cults came to light, particularly related to the 'pantheon' of the Great Mother.

41 Varro, *Eum.* fr. 120 Bücheler.

42 Catullus, *Carmen LXIII*: 12-13 and 17: 'Agite ite ad alta, Gallae, Cybeles nemora simul,/imul ite, Dindymenae dominae vaga pecora'; 'et corpus evirastis Veneris nimio odio'.

43 Catullus, *Carmen LXIII*: 19-26: 'Mora tarda mente cedat: simul ite, sequimini/Phrygiam ad domum Cybebes, Phrygia ad nemora deae,/ ubi cymbalum sonat vox, ubi tympana reboant,/tibicen ubi canit Phryx curvo grave calamo,/ubi capita Maenades vi iaciunt hederigerae,/ubi sacra sancta acutis ululatibus agitant,/ubi suevit illa divae volitare vaga cohors,/quo nos decet citatis celerare tripudiis'.

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Sound illustrations

Fig. 17: A '*Tarantolata*', excerpt from a film by Gian Franco Gilmozzy.

Fig. 18: *PIZZICA* from '*La Tarantella-Antidotum Tarantulae*', L'Arpeggiata & Christina Pluhar, track 15.

Fig. 19: *N'DREZZATA* from '*Feste e tamburi in Campania*', live recording by Michele Gala, vol. I, track 6.

Fig. 22: *TAMMURRIATA*, by Lomax recordings, from 'Folk Music and Song of Italy', *The Alan Lomax Collection*, track 13.

1	*išartu*						Dorian	
	E	F	G	A	B	C	D	

2	*kitmu*						Hypodorian	
	E	F$^#$	G	A	B	C	D	

3	*embūbu*						Phrygian	
	E	F$^#$	G	A	B	C$^#$	D	

4	*pītu*						Hypophrygian	
	E	F$^#$	G$^#$	A	B	C$^#$	D	

5	*nīd qabli*						Lydian	
	E	F$^#$	G$^#$	A	B	C$^#$	D$^#$	

6	*nīš* GABA.RI*						Hypolydian	
	E	F$^#$	G$^#$	A$^#$	B	C$^#$	D$^#$	

7	*qablītu*						Mixolydian	
	E$^#$	F$^#$	G$^#$	A$^#$	B	C$^#$	D$^#$	

Fig. 1. * Read *niš tuḫri*.†

NEW LIGHT ON THE BABYLONIAN TONAL SYSTEM

Leon Crickmore

One of the most significant developments in recent musicology has been the transcription and interpretation of a number of musical cuneiform tablets dating from the second millennium B.C. It has been established that Old Babylonian music was diatonic and based on seven heptachords, corresponding to the first seven tones of the ancient Greek octave species. But a problem remains about the direction of these scales. This paper will suggest a resolution of the 'dilemma' reached by Kilmer in her pioneering research. It will also argue that the theoretical musicians of ancient Mesopotamia are likely to have quantified their scales, using sexagesimal arithmetic and numbers from their standard tables of reciprocals. The resulting tuning would therefore have been Just rather than Pythagorean.

During the second half of the last century, our understanding of the history of music was significantly extended as a result of the transcription and interpretation of a number of musical cuneiform texts dating from the second millennium B.C. For musicians - and possibly for the general reader, too - the most accessible and succinct summary of this research is to be found in Kilmer's article under the heading 'Mesopotamia', in the New Grove Dictionary of Music and Musicians. According to Kilmer[1] 'from the Old Babylonian to the Seleucid periods a standard corpus of Akkadian terms was used to describe seven heptatonic diatonic tuning sets or scales.' The archaeological evidence for our knowledge of the Mesopotamian tuning system, she continues: 'derives from nearly 100 cuneiform tablets'. Of these, three main texts will be crucial to my argument: namely, CBS 10996, UET VII 74 and CBS 1766. However, before commenting on each of these, for the benefit of those who are familiar with modern musical notation by letter-names, Kilmer's transcription of the Mesopotamian heptachords is presented (fig. 1).

Musicians will note that Kilmer and the musicologists with whom she worked have assumed that the scales were rising and corresponded to the ancient Greek octave species, the names of which appear on the right. Moreover, to be even more technical for a moment, the scales have been notated chromatically within a single octave - that is thetically, rather than dynamically - a point to be considered further. The *išartum* mode is the only scale expressed exclusively by means of letters corresponding to the white keys of a piano. The orthographically trained will have noticed that Kilmer gives the string-pair or scale names without mimation.

Commentary and Interpretation

The aim of this paper is to complement the work of archaeologists and textual scholars, by providing, from a musicological perspective, a commentary on and interpretation of the content of three cuneiform texts in particular: CBS 10996, UET VII 74 and CBS 1766.

CBS 10996 is a Neo-Babylonian text, published by Kilmer.[2] UET VII 74 is Old Babylonian. It was originally published by Gurney,[3] but later revised.[4] CBS 1766 is a badly damaged tablet of uncertain provenance and date. It was only published as recently as 2006.[5] In addition to a table of numbers, the text includes an unusual geometrical structure. The inscription above the numerical columns remains largely unintelligible, although recent work by a team at the British Museum suggests a link with the Middle-Assyrian song-list KAR 158.

† The Old Babylonian equation of the pseudo ideogram GABA.RI has recently been rendered as *niš tuḫrum*. See Krispijn-Mirelman, *Iraq* (forthcoming).

Basic tuning	Fine tuning	Heptachordal name
1-<u>5</u>	7-<u>5</u>	*nīš* GABA.RI*
2-<u>6</u>	1-<u>6</u>	*išartu*
3-<u>7</u>	2-7	*embūbu*
4-<u>1</u>	<u>1</u>-3	(*nīd qabli*)
5-<u>2</u>	<u>2</u>-4	(*qablītu*)
6-<u>3</u>	<u>3</u>-5	(*kitmu*)
7-<u>4</u>	<u>4</u>-6	(*pītu*)

Fig. 2. * Read *niš tuḫri*.

CBS 10996 lists fourteen pairs of integers between one and seven. The logogram 'SA', preceding the numbers, means a 'string', and suggests a tuning procedure for a seven-stringed instrument. If this is so, the odd-numbered lines from 11-24 refer to pairs of strings defining musical intervals of fifths and fourths. Modern string players still tune their instruments by fifths and fourths, although, unlike their Babylonian counterparts, modern musicians trained to think in terms of relationships between musical pitches rather than between named string-pairs, exclude the 'unclear' interval of the tritone (the diminished fifth or augmented fourth) from an integral role in the procedure. On the other hand, as will emerge later in the discussion of UET VII 74, the Babylonian tuning system could be construed as a cyclic procedure for the correction of tritones. Kilmer[6] interprets the seven 'dichords' (pairs of strings) in my left-hand column as a description of a method for tuning seven strings to each of seven modes or heptachords, with the outcome I have already indicated in figure 1. Smith and Kilmer[7] interpret the dichords of the even-numbered lines between 11 and 24 - that is, those in the righthand column of figure 2 - as a means of 'fine-tuning' the thirds and sixths in each of the seven scales, usually through the adjustment of the common string whose number is underlined in the figure. They consider the likely function of this procedure would be to make the thirds and sixths sound 'sweeter'. This would imply bringing the basic Pythagorean tuning closer to what acousticians call Just tuning - another matter to be considered in greater detail later. The dichords in the even-numbered lines have their own textual descriptions.

UET VII, 74

Kilmer[8] states that it was this text (which she refers to as U. 7/80, its field number) which convinced scholars that heptatonic diatonic scales must be the correct interpretation of the tuning tablets. Unfortunately, it has also left her own pioneering research work 'on the horns of a dilemma.'[9]

For in the secondary literature concerning CBS 10996 and UET VII 74, a difference of opinion emerges about whether the heptachordal scales should be interpreted as rising or falling. Musicologists have been uncertain about whether the word 'qudmu' ('foremost string') in CBS 10996, refers to the string sounding the highest or the lowest pitch. When Gurney first published UET VII 74 in 1968, everyone assumed that the scales defined in the tablet were ascending. However, some years later, the musicologist, Vitale,[10] argued that the string descriptions 'thin' and 'small' in UET VII 126 must refer to higher-pitched strings, and in consequence the scales in UET VII 74 ought to be descending. Then the Assyriologist, Krispijn,[11] proposed an improved reading of the twelfth line of UET VII 74 which supported Vitale's view. The relevant portion of line 12 originally read: 'NU SU', 'no more', that is, 'end of sequence'. Krispijn considered that damaged signs were compatible with 'ḫu-um', and suggested 'nusuḫ(u-um)', the infinitive of the verb 'nasaḫum', 'to tighten'. Gurney[12] therefore, issued a revised transliteration, as a result of which most textual scholars and musicologists have accepted that (with regard to UET VII 74 at least) the scales defined must be falling. Such a consensus, however, created a problem for Kilmer, for while it is true that the tuning procedures she had derived from CBS 10996 can be applied in either an upward or a downward direction, the change of direction results in different names for the scales. The only scale which retains the same name whether rising or falling is *embūbum*. Fig. 3 indicates the anomalies in nomenclature.

Vitale	Kilmer
išartum	*nīd qablim*
embūbum	*embūbum*
nīd qablim	*išartum*
qablītum	*nīš* GABA.RI*
kitmum	*pītum*
pītum	*kitmum*
nīš GABA.RI*	*qablītum*

Fig. 3. *Read *niš tuḫrim*.

Kilmer frankly admitted this dilemma, but at the same time expressed her belief that 'we have not arrived at the end of the discussions of this subject' and 'perhaps the answer will lie in our eventual ability to understand how 'pitch sets' could work either up or down'.[13] A possible escape route out of this dilemma, was published earlier this year.[14][15] The musicologists who assisted in the recovery of the Mesopotamian tuning system were perhaps too eager to relate its scales to the octave species of ancient Greece. Kilmer[16] notes that no-one has yet identified a Sumerian or Akkadian word for 'octave'.

The octave may not have been thought of as a unit in its own right, but rather by analogy like the first day of a new seven-day week. Nicomachus, writing in the second century A.D., devotes the whole of the fifth chapter of his *Manual of Harmonics* to the thesis that 'Pythagoras, by adding the eighth string to the seven-stringed lyre, instituted the attunement of the octave' (for full text and commentary see Levin[17]). The pioneering musicologists were not comparing like with like, but seven-note scales (heptachords) with eight-note scales (octachords). Thus, for example, when defined as a series of tones (t) and semitones (s), the heptachord *išartum* would be stttst, corresponding to the first seven tones of the ancient Greek Dorian scale, rising. But the first seven notes of the falling Dorian octave, starting from the octave above the original note, displays a different pattern: ttsttt - the pattern of the heptachord with the alternative name in figure 3, that is '*nīd qablim*', corresponding to the Lydian octave species and our modern major scale. Each of the heptachords forming a pair in figure 3 are in fact the mirror image of each other. '*embūbum*' is the only scale which keeps the same name in both columns. This is because the pattern of tones and semitones in the octave to which it belongs (the Phrygian) is palindromic: tstttst. If one were to quantify the Babylonian heptachords mathematically, using tone-numbers to express ratios of string-length, the pairs of scales carrying the same name in both columns of figure 3 would be the inverse or reciprocal scales of each other. The Greek octave species and our modern scales consist of ladders of musical pitches. It is these pitches which remain unchanged when the direction of the scale is reversed. The names of the Babylonian scales, however, may be taken to represent specific modal patterns of tones and semitones, and it is these patterns which remain identical whether the heptachord is rising or falling. If my proposed solution to the problem of nomenclature is correct, it seems likely that a remnant of the Babylonian system may have survived in our modern melodic minor scales.

The upper tetrachord of such scales rises and falls in an identical modal pattern: tts, and although the pitches of the scale-ladder change when its direction is reversed,

the name of the scale does not. Figure 4 displays the modal patterns of the seven Babylonian heptachords by name.

By focussing on the direction of the scales - a perennial problem in musicology - the musicological significance of UET VII 74 has not yet been explained. The tablet as a whole comprises a cyclical method of tuning and re-tuning a nine-stringed instrument through seven modes in an upward and a downward series. Each of the quatrains of the text follow a similar pattern along the following lines: (1) when the instrument is tuned to scale A, (2) the 'unclear interval' (assumed to be the tritone) falls between strings x and y, (3) tighten string x by a semitone (or, in part 2, tune down string y by a semitone) and (4) the instrument will be tuned to scale B. The names ('*išartum*', '*qablītum*' and so on) refer initially to pairs of strings (the dichords in CBS 10996). The heptachords are called after the dichord which in the previous scale of the series sounded a tritone, but which by the sharpening or flattening of one of its members has now become a perfect fifth. Dumbrill,[18] has elucidated the text succinctly. Figures. 5 and 6 tabulate the tuning procedure. For the construction of these figures. I have used '*išartum*' in its descending form. Figure 5 demonstrates the cycle of tuning by 'tightening', as described in the first part of UET VII 74.

In the '*išartum*' heptachord the tritone lies between the fifth and the second string. The player is instructed to tighten the fifth string in order to tune the instrument to the heptachord '*qablītum*'. Subsequently, in turn, the c, g, a and e are similarly sharpened until the heptachord '*kitmum*' is reached. If, finally, the b in '*kitmum*' is sharpened, the instrumental tuning returns to the original '*išartum*' tuning, but now transposed up a semitone.

Figure 6 shows the tuning procedure by 'loosening', explained in the second part of the text. I have notated this tuning-cycle, beginning from the white-key version of '*išartum*' used in figure 5. It could just as well have started with the transposed version of the scale with which figure 5 ends. This would simply have reversed the tuning procedure in figure. 5, until it returned to the initial white-key scale of '*išartum*'.

In figure 6, however, the b, e, a, d, g and c of

1		2		3		4		5		6		7		String number
Modal Pattern (string intervals)														Name
	s		t		t		t		s		t			*išartum*
	t		s		t		t		t		s			*embūbum*
	t		t		s		t		t		t			*nīd qablim*
	s		t		t		s		t		t			*qablītum*
	t		s		t		t		s		t			*kitmum*
	t		t		s		t		t		s			*pītum*
	t		t		t		s		t		t			*nīš* GABA.RI*

Fig. 4. * Read *nīš tuḫrim*.

No	1		2		3		4		5		6		7	Tritone	Retuning
Name	*išartum*														
	c"		b'		a'		g'		f'		e'		d'	5-2	5♯
		s		t		t		t		s		t			
Name	*qablītum*														
	c"		b'		a'		g'		f♯'		e'		d'	1-5	1♯,8♯
		s		t		t		s		t		t			
Name	*nīš* GABA.RI*														
	c♯"		b'		a'		g'		f♯'		e'		d'	4-1	4♯
		t		t		t		s		t		t			
Name	*nīd qablim*														
	c♯"		b'		a'		g♯'		f♯'		e'		d'	7-4	7♯
		t		t		s		t		t		t			
Name	*pītum*														
	c♯"		b'		a'		g♯'		f♯'		e'		d♯'	3-7	3♯
		t		t		s		t		t		t			
Name	*embūbum*														
	c♯"		b'		a♯'		g♯'		f♯'		e'		d♯'	6-3	6♯
		t		s		t		t		t		s			
Name	*kitmum*														
	c♯"		b'		a♯'		g♯'		f♯'		e♯'		d♯'	2-6	2♯,9♯
		t		s		t		t		s		t			

Fig. 5. *Read *niš tuḫrim*.

'*išartum*' (the twin partners of the member of the tritone sharpened in figure 5) are each, in turn, flattened, until the heptachord '*qablītum*' is reached. The loosening of the fifth string (f) in this scale would return the tuning of the instrument to '*išartum*', but this time tuned a semitone lower than at the start.

Mesopotamian Music Theory

Assyriologists accept that the Mesopotamians must have had their own system of music theory. The interpretation of the relevant evidence is a matter for musicologists. Before, therefore, dealing with the third cuneiform text (CBS 1766), two further questions need to be considered:

No	1		2		3		4		5		6		7	Tri-tone	Retuning
Name	*išartum*														
	c''		b'		a'		g'		f'		e'		d'	5-2	2♭,9♭
		s		t		t		t		s		t			
Name	*kitmum*														
	c''		b♭'		a'		g'		f		e'		d'	2-6	6♭
		t		s		t		t		s		t			
Name	*embūbum*														
	c''		b♭'		a'		g'		f'		e♭'		d'	6-3	3♭
		t		s		t		t		t		s			
Name	*pītum*														
	c'		b♭'		a♭'		g'		f'		e♭'		d'	3-7	7♭
		t		t		s		t		t		s			
Name	*nīd qablim*														
	c''		b♭'		a♭'		g'		f'		e♭'		d♭'	7-4	4♭
		t		t		s		t		t		t			
Name	*nīš* GABA.RI*														
	c''		b♭'		a♭'		g♭'		f'		e♭'		d♭'	4-1	1♭,8♭
		t		t		t		s		t		t			
Name	*qablītum*														
	c♭''		b♭'		a♭'		g♭'		f'		e♭'		d♭'	1-5	5♭
		s		t		t		s		t		t			

Fig. 6. *Read *niš tuḫrim.*

(1) did the theoretical musicians of ancient Mesopotamia define their musical scales mathematically? and

(2) if so, what was the nature of their idealized tuning model? The picture of the Babylonian tonal system that has emerged so far, will also be summarised as a single diagram.

Quantification

The musicologist Crocker,[19] suggests that the Babylonians could have quantified their scales, adding: 'they certainly had the mathematical capacity - indeed the needed numbers are there in the mathematical texts'. But Gurney and West[20] respectively an Assyriologist and a classical

scholar, retorted: 'since there is no evidence that the Babylonians had any notion of this, there is little point in speculating that they might have done, or that such evidence might yet turn up'. Differences of opinion of this kind are only exacerbated if scholars insist on restricting their research rigorously within a single discipline and a single set of academic criteria. If we seriously wish to increase our understanding of questions of this kind, assyriologists and textual scholars need to have honest dialogue with musicians and historians of mathematics. Interdisciplinary teamwork has become essential. Numerous examples exist of mathematical cuneiform tablets from the scribal schools of nineteenth and eighteenth century Larsa, Ur and Nippur, which contain thirty standard pairs of numbers with their reciprocals, encompassing all the sexagesimally regular numbers from 2-81. It was the musicologist, Ernest McClain[21] who first suggested that these numbers, all in the form $2^p 3^q 5^r$ seem 'perfectly engineered to fit the specific needs of mathematical harmonics'. It is unfortunate that scholars have paid so little attention to McClain's ideas,' though, happily, more recently the mathematician Kappraff[22] has devoted the entire third chapter of a recent book to the arithmetic of 'Harmonic Law', supporting McClain's suggestions. Elsewhere Crickmore[23] has provided a re-evaluation of the cultural significance of this ancient science of harmonics.

In his article on the 'Musicality of Plato'[24] he further indicated how Plato's 'sovereign geometrical number' (Republic, 546c), namely 60^4 - an intrinsic component of sexagesimal arithmetic - together with certain of its factors, which Plato refers to as 'two harmonies', can be used to quantify the seven Babylonian heptachords.

Figure 7 from Robson[25] shows the text MLC 1670, a typical example of a standard table of reciprocals. Each of its numbers could be used to define a musical pitch. The range 24-60, highlighted, would sound a continuous scale.

Within this, 27-48 defines the Babylonian heptachord '*embūbum*'. The same scale, with an added octave note (54), was known to the ancient Greeks as the Phrygian octave species; in the Christian church it became the first ecclesiastical mode; by musicians of the renaissance and in modern times it was known as the Dorian mode. Thus the diatonic scale has survived intact for at least four thousand years.

Figure 8 shows a transcription of the range 24-60 of figure 7 as tone-numbers, representing hypothetical musical pitches: on the extreme right, the falling '*embūbum*' heptachord is indicated; on the left side, the first three columns show the corresponding rising scale, including, within its octave, Kilmer's rising '*išartum*' from figure 1.

The ratios between the tone-numbers represent ratios and reciprocal ratios of string-length. The tone-numbers 25 and 50 are redundant with regard to defining the heptachords. But they become crucially relevant in deter-

Two thirds of 1 is 0;40.	The reciprocal of 24 is 0;02 30.
Its half is 0;30.	The reciprocal of 25 is 0;02 24.
The reciprocal of 2 is 0;30.	The reciprocal of 27 is 0;02 13 20.
The reciprocal of 3 is 0;20.	The reciprocal of 30 is 0;02.
The reciprocal of 4 is 0;15.	The reciprocal of 32 is 0;01 52 30.
The reciprocal of 5 is 0;12.	The reciprocal of 36 is 0;01 40.
The reciprocal of 6 is 0;10.	The reciprocal of 40 is 0;01 30.
The reciprocal of 8 is 0;07 30.	The reciprocal of 45 is 0;01 20.
The reciprocal of 9 is 0;06 40.	The reciprocal of 48 is 0;01 15.
The reciprocal of 10 is 0;06.	The reciprocal of 50 is 0;01 12.
The reciprocal of 12 is 0;05.	The reciprocal of 54 is 0;01 06 40.
The reciprocal of 15 is 0;04.	The reciprocal of 1 00 is 0;01.
The reciprocal of 16 is 0;03 45.	The reciprocal of 1 04 is 0;00 56 15.
The reciprocal of 18 is 0;03 20.	The reciprocal of 1 21 is 0;00 44 26 40.
The reciprocal of 20 is 0;03.	<Its half>

Fig. 7

mining the nature of the thirds and sixths produced by the fine-tuning procedure of CBS 10996. The tuning system which these tone-numbers generate is known technically as 'Just' - a matter that calls for further explanation.

A Case for Just Tuning

Modern science measures pitch in terms of frequency of vibration (Herz). However, since the ancients were unable to measure frequency accurately, they relied instead on ratios of string-length, assuming that all other factors such as the tension and thickness of strings remained constant. The earliest surviving Greek treatise on tuning the musical scale, '*The Division of the Canon*', may date from as early as the turn of the fourth century B.C., and is often attributed to Euclid[26]. The first explicit description of an extended diatonic scale expressed in tuning ratios occurs in Plato's dialogue *Timaeus* (34-7), where it appears in the form of a creation myth as the 'World Soul'. When transcribed musically, the first octave of the 'World Soul' turns out to be the ancient Greek Dorian mode. All the tones are 9:8. This means that the semitone has to be that which is left over (Greek *leimma*) when a diatonic third $(9/8)^2$ is taken from a perfect fourth (4/3), that is 4/3 divided by $81/64 = 256/243$. This tuning system is known as

Pythagorean. Mathematically, all its tonenumbers are in the form $2^p 3^q$. 'Just' tuning, on the other hand, also uses the prime number 5 as a generator. Its commonest semitone is 16:15. There are two kinds of tone: 9:8 and 10:9. Its major third is pure, 5:4, as in the harmonic series produced by a natural trumpet. The difference between a Pythagorean diatonic third $(9/8)^2$ and a pure third (5:4) is called by modern acousticians the 'syntonic *comma*'. Its value is 81:80. Friberg[27] cites a mathematical problem in the Seleucid text AO 6484:7. 'In this exercise', he writes, 'the terms 'igi' and 'igi.bi' denote a reciprocal pair of (positive) sexagesimal numbers such that their product is equal to '1' (any power of 60)'. This sounds uncannily like an exercise in the symmetry of harmonic arithmetic. For instance, if we express a perfect fifth (3:2) as 90/60, and its reciprocal (2:3) as 40/60, then 90 x 40 = 60^2.

Also, any musical ratio, expressed as a fraction and multiplied by its reciprocal equals unity (for example, 4/1 x 1/4 = 1; 4/3 x 3/4 =1), and unity (60^0 =1) serves as their geometric mean.

Unity functioned as the fulcrum of ancient mathematics, which, unlike modern mathematics lacked both zero and negative numbers. Friberg gives the solution to the problem as 'igi' = 81/80 and 'igi.bi' = 80/81.

Both 80 and 81 are regular numbers and appear in the reciprocal tables. Could this problem, then, possibly represent a calculation of the syntonic *comma*, thus providing a theoretical underpinning for the practical fine-tuning procedures, the 'sweetening' by ear of the thirds, described in CBS 10996? While this idea must remain pure speculation, the very existence of 'igi'-'igi.bi' mathematical problems, together with the musical connotation of the ratios between the regular numbers in the standard tables of reciprocals, may be taken to suggest that the arithmetic of Just tuning was known at an early date to the theoretical musicians in the temples of Mesopotamia.

On the basis of tablets K170 and Rm 520, Livingstone[28] lists numbers associated with the Babylonian gods: Anu (60), Enlil (50), Ea (40) and Sin (30). The ratios between these numbers also define the main intervals of Just tuning. The perfect fifth (60:40) and the perfect fourth (40:30) are the intervals required for the 'rough' tuning described in CBS 10996; the major third and sixth (50:40 and 50:30), the minor third (60:50) and, (if we allow the octave double of 40) even the minor sixth (80:50), all intervals needed for the subsequent 'fine-tuning'. In UET VII 126, a string listed as 'fourth, small string' in Sumerian, is called 'Ea-created' in Akkadian. If the 'normal' heptachord tuning (*išartum*) is defined in tone-numbers taken from the tables of reciprocals, starting at 30 (Sin), the tone-number of the fourth string will be 40, the number of Ea, patron of music. Thus the four main 'god' numbers (60,50,40,30) occur in the 24-60 range of the reciprocal tables, as do the ratios for the two kinds of tone (9:8 and 10:9) and also the three kinds of semitone (16:15, 27:25, 25:24) needed for the Just tuning of a chromatic scale in the octave 360-720.

Dumbrill[29] has drawn attention to a seal in the British Museum depicting a female musician with a lute. This seal (BM 141632) belongs to the Uruk period some eight hundred years before any previously known representation of the instrument. The lute is a fretted instrument. Dumbrill hypothesizes that the procedure of fretting could have been the origin of the use of ratios and proportional arithmetic to define musical tuning. Fretting involves the proportional shortening of a string. If the necessary measurements were expressed as tone-numbers, the ratios between them would represent 'inferred vibration' - or, as we would call it 'frequency'. The earliest scales would therefore have been rising, as Kilmer originally assumed. It seems possible that with the increasing sophistication of mathematics and tuning theory, ratios of string-length, and consequently falling scales, may have become the norm by the Old Babylonian period, and remained so until after the era of Classical Greece.

If this is so, the tuning ratios could have remained unchanged: they would only require a different interpretation. For we now know that frequency varies in inverse proportion to string-length, but it remains uncertain when the ancients intuitively recognised this fact. In practice, of course, musicians, ancient or modern, tune their instruments by ear, taking account of the acoustics of their particular instrument and of the place of performance.

This inevitably results in some slight degree of diversity between tunings, usually only discernable by a trained ear. Nevertheless, each age tends to favour a particular norm as its own, and all actual tunings approximate to this model. In ancient Greece, for example, the model was Pythagorean tuning; in modern times it is equal temperament.

In the light of all the evidential hints cited, therefore, we may conclude, as a working hypothesis, that the theoretical musicians of ancient Mesopotamia quantified their heptachordal scales in sexagesimal arithmetic, using numbers from their standard tables of reciprocals, and that, as a result, their tuning system would have been 'Just', rather than Pythagorean, as has so far been assumed. In the West the earliest documentary evidence for Just tuning is in the harmonics of Ptolemy[30], as late as the second century A.D. But McClain[31] reports on a remarkable piece of archaeological evidence from China, where, in ancient times, there were seven heptachords similar to the Babylonian scales[32]. The tuning of a carillon of 65 bronze bells recovered from a tomb dating from 433 B.C. is 'Just'. Bearing in mind that, for example, historians of mathematics have now established that Pythagorean triples were known in Mesopotamia a thousand years before Pythagoras, is it not conceivable that mathematicians understood the arithmetic of Just tuning, and that their practical musicians used it, as far back as 1500 years before the Chinese carillon? Figure 9 summarizes all that has been

Regular Number in tables of reciprocals	Rising pitch	Ratio of string length rising	Ratio of string length falling	Falling pitch
24	C^6			E^4
25	$C^{\sharp 6}$			$E^{\flat 4}$
27	D^6	9:10	10:9	D^4
30	E^6	15:16	16:15	C^4
32	F^6	8:9	9:8	B^3
36	G^6	9:10	10:9	A^3
40	A^6	8:9	9:8	G^3
45	B^6	15:16	16:15	F^3
48	C^7	8:9	9:8	E^3
50	$C^{\sharp 7}$			$E^{\flat 3}$
54	D^7	9:10	10:9	D^3
60	E^7			C^3
		Reciprocals		

embūbum (left and right); *išartum* (center); e.t.c.

Fig. 8. Regular numbers as tone-numbers (C4 =middle C) with ratios of string length.

inferred so far, in the light of evidence from archaeology, musicology and mathematics, about the Babylonian tonal system. For the sake of simplicity, in this figure the heptachords are notated using letters representing the white keys of the piano only.

Although a modern piano is tuned to equal temperament - that is, all twelve semitones are equal in size, and their mathematical expression involves irrational numbers and a logarithmic spiral which would have been beyond the capacity of ancient Mesopotamian mathematicians - nevertheless, for the purpose of practical explanation, the use of the white keys, though approximate, is quite adequate.

Technically, this form of presentation is described as 'dynamic' in contrast to the 'thetic' notation of previous examples. Also, in view of the current state of the debate about Kilmer's work, the scales are presented initially as rising, starting from Kilmer's original transcription of '*išartum*'. The corresponding falling scales have been added in dotted lines. Presented in this manner, the symmetry between the black and the dotted is stunning. Musically, it is accurate in terms of the patterns of tones and semitones. But it will be noticed that in '*išartum*', for example, the highest tone of the rising scale (9:8) differs from the lowest tone in the falling scale (9:10). To remedy this would require us to place the scales in the octave 144-72, the smallest integers capable of corresponding to the reciprocals of 30-54. Figure 9 shows the string numbers, pitches, tone-numbers ratios and intervals for each of the seven Babylonian heptachords. The numbers in the reciprocal tables have been extended beyond 81 to include 96 and 108, the octave doubles above 48 and 54. Capital

letters in the columns on the extreme left and right, relate to cuneiform tablet CBS 1766, on which I shall comment next.

CBS 1766

CBS 1766 was published by Horowitz.[33] The tablet is unusual in that it is headed by a seven-pointed star within two concentric circles, (fig. 10). Below this are columns of seven integers between one and seven. Horowitz reads the figures in pairs horizontally and proposes a mathematical interpretation.

Waerzeggers and Siebes[34] propose an alternative musical interpretation. They read the figures in pairs by column. Thereby they relate the numbers to the seven-pointed star, which they interpret as a visual tuning-chart for a seven-stringed instrument, supplementing the numerical and verbal instructions contained in CBS 10996. The musical interpretation is supported by the research team here at the British Museum.[35]

Figure 11 indicates how the text, with three emendations, might have originally been intended to be understood. The names of the heptachords produced by Kilmer's tuning procedure are listed and identified by capital letters which relate them both to Horowitz's transcription of the tablet and to my figure 9.

In the original, the last four columns on the right are empty, except for line one. The numbers in columns E, F, G and H are extrapolations from Waerzeggers and Siebes's reading of the first line as 5, 4, 3, 2. However, a team at the British Museum has recently suggested an improved and extended reading: 5, 2, 5, 2, 5, 2. Since 5-2 is the tritone in the '*išartum*' scale (column A), its triple use over empty columns may be a kind of musical shorthand

to indicate the application of the tritone procedure from UET VII 74 (figs 5 and 6) to the scales defined in detail in columns A-D, with a view to generating heptachords for columns E-H. The application of such a procedure would, in effect, produce an identical musical result to my extrapolation in figure 11. Alternatively, the integers 5 and 2 may refer to the heptachords 'qablītum' (5-2) and 'išartum' (2-6) as appropriate modes for certain classes of incantation which the British Museum team think might be listed in the textual heading to the geometrical figure. However, as long as the heading remains almost indecipherable, and the overall context remains musical, we may believe that Waerzeggers and Siebes's interpretation adequately represents the most likely intention of the author of the tablet.

Textual scholars may helpfully be able to throw more light on whether these incantations are imprecations of the scribe, or of a musician, or whether they correspond to items in the song-list KAR 158, which sometimes indicates the appropriate musical modes for certain classes or styles of music (fig. 12).

For this figure, the information in figure 9 is compressed into a single octave, and projected onto the seven-pointed star from CBS 1766. At the centre is information derived from CBS 10996. The heptachords are displayed as falling to the right in black, and rising to the left in red. The initial 'rough' tuning by fifths and fourths is indicated in red; while the subsequent 'fine-tuning' of the thirds is shown by added lines in green.

Thus, for instance, the tuning algorithm for *išartum* is represented by 2-6 (red), followed by 1-6 (green).

The modal patterns of the scales are identical with those generated by the tuning procedure in UET VII 74 (figs 5 and 6), except that here they are notated dynamically rather than thetically. Thus CBS 10996, UET VII 74 and CBS 1766 are all musically compatible with each other. Next, moving outwards from the centre, the respective tone-numbers from the standard tables of reciprocals, noting the ratios between them. Finally, around the outer circle, I have listed the modern pitch equivalents by letter name, together with alternative numberings of the modes, which correspond to Kilmer's interpretation (red), and to Vitale's (black).

The two concentric circles surrounding the seven-pointed star in CBS 1766 may carry some geometrical and associative meaning. Or, the entire picture may perhaps be a design for some kind of rotating mechanism, like an astrolabe, but for the purpose of tuning an instrument to the appropriate mode for an incantation as listed in the cuneiform tablet KAR 158.

But such possibilities are matters for others to consider. The question which the tablet poses for musicologists is this: could CBS 1766 be the earliest known example of a tone-circle?

At present, the earliest known reference to a tone-circle occurs in the Harmonics of Ptolemy.[36] In the passage in question, Ptolemy bends round the two-octave scale of the ancient Greek Greater Perfect System into a circle to match the ecliptic. In Ptolemy's tone-zodiac, the circle is divided into twelve equal parts as can be done with compasses.

Geometrically, at least, this could correlate with a double octave whole-tone scale in equal temperament.

But mathematicians are right to be sceptical about the validity of ancient tone-circles for which the mathematical expression requires logarithms. Besides, in the text, Ptolemy explicitly associates his tone-circle with the Greater Perfect System, a diatonic scale in which some intervals are tones and others semitones. Ptolemy is probably simply drawing an analogical, rather than a quantitative parallel between a circle, the Greek tonal system and the ecliptic. Similarly, in CBS 1766 the circle is divided into seven approximately equal segments which do not represent equal measures of distance: heptachordal scales comprise two sizes of tones and one of a semitone.

Ancient diagrams of symbolic geometry, such as we find in CBS 1766, may have never been intended to be construed as precisely accurate with regard to particular measurements, but rather understood as approximations of the kind later known as Diophantine. These are entirely adequate for the purposes of analogical philosophy and primitive cosmological thinking. Modern science undoubtedly achieves greater accuracy when it measures musical intervals in cents, or ancient temples and mediaeval cathedrals in metres, but the price of such accuracy is that the proportional integer ratios essential to the structures of musical scales and sacred buildings are thereby concealed.
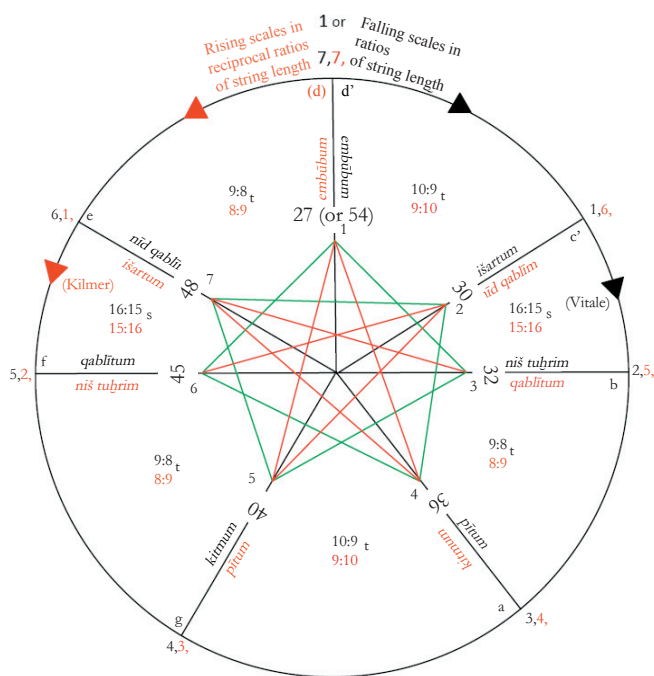
The Nature of the Evidence

Finally, although much of the evidence supporting my reconstruction of the Babylonian tonal system is circumstantial and dependent on musicological interpretation of such archaeological evidence as has survived, the case I have presented has mathematical consistency and is compatible with what we now know about Babylonian mathematics. It may be considered, therefore, worthy to be treated as plausibly credible. As we continue to unravel Middle Eastern cultures of the past there is likely to be an increasing need for closer co-operation and tolerant understanding between archaeologists, Assyriologists, musicologists and historians of mathematics. Professor Finley[37] once wrote: 'there is eminent authority for the view that questions about the past can be answered at least approximately, through the imagination, provided it is disciplined by an underpinning of sound scholarship'. It is for the reader to decide how far this paper has managed to meet Professor Finley's criterion.

String number	1		2		3		4		5		6		7		6		5		4		3		2		1
Pitches	c_5		b_4		a_4		g_4		f_4		e_4		d_4		c_4		b_3		a_3		g_3		f_3		e_3
Tone-numbers	96		90		80		72		64		60		54		48		45		40		36		32		30
Ratios		16:15		9:8		10:9		9:8		16:15		10:9		9:8		16:15		9:8		10:9		9:8		16:15	
Ratios		15:16		8:9		9:10		8:9		15:16		9:10		8:9		15:16		8:9		9:10		8:9		15:16	
Intervals		s		t		t		t		s		t		t		s		t		t		t		s	

(A) išartum
(C) niš GABA.RI*
(D) pītum
(B) kitmum
(E) qablītum
(F) nīd qablim
(G) embūbum

Fig. 9. * Read *niš tuḫrim*.

Fig. 10

Rising scales in reciprocal ratios of string length

1 or **Falling scales in** ratios **7,7,** of string length

embūbum / embūbum
9:8 t / 8:9
10:9 t / 9:10
27 (or 54)

nīd qablu / išartum
6,1, e
16:15 s / 15:16
(Kilmer)
48 7

išartum / nīd qablim
1,6, c'
30 2
16:15 s / 15:16
(Vitale)

qablītum / niš tuḫrim
5,2, f
45 6
32 3
niš tuḫrim / qablītum
2,5, b

9:8 t / 8:9
40 5
9:8 t / 8:9
36 4

kitmum / pītum
10:9 t / 9:10
pītum / kitmum
3,4, a

g
4,3,

CBS 1766 as a Tone Circle

Notes and Key:

The tritonic tuning procedire of UET VII 74
can be applied to falling scales
t = Tone
s = Semitone
c' = Middle c
Figures in red indicate reciprocal (inverse) scales

Red and green lines = Dichords in CBS 10996
Red lines = Initial Tuning 5ths/4ths
Green lines = Fine tuning (3rds and 6ths)

Fig. 12

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
2	6	1	7	5	4	3	2
6	3	5	4	2	1	7	6
3	7	2	1	6	5	4	3
7	4	6	5	3	2	1	7
4	1	3	2	7	6	5	4
1	5	7	6	4	3	2	1
5	2	4	3	1	7	6	5

Key		
(A)	*išartum*	(6 emended to 5)
(B)	*kitmum*	
(C)	*nīš* GABA.RI*	(5 emended to 4)
(D)	*pītum*	
(E)	*qablītum*	
(F)	*nīd qablim*	
(G)	*embūbum*	(7 emended to 3)
(H)	Return to *išartum*	

Fig. 11. * Read *niš tuḫrim.*

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THE ANCIENT MESOPOTAMIAN SISTRUM AND ITS REFERENCES IN CUNEIFORM LITERATURE: THE IDENTIFICATION OF THE *ŠEM* AND *MEZE**

Uri Gabbay

Unlike ancient Egypt, where the sistrum was very common, and is known from many iconographical, textual and archaeological sources,[1] rattles and sistra are very rare in ancient Mesopotamian sources. There are no Mesopotamian archaeological finds that can be identified with certainty as sistra, and there are only a handful of iconographical representations of sistra or rattles. In this article I will review the iconographical evidence for Mesopotamian sistra and rattles, and will attempt to identify the Sumerian and Akkadian terms for them as we know them from cuneiform texts.

Iconographical Representations of Rattles/ Sistra

Below is a list of the iconographical scenes exhibiting rattles and sistra in chronological order:

(1) The first representation is from the royal tombs of Ur (fig. 1).[2] The wooden sound box of one of the lyres found in this tomb contained a shell inlay on its front. On the third register of this inlay we find a scene of animals playing musical instruments: a donkey, or mule, plays a bull-based lyre supported by a bear, and a fox, or jackal, plays a rattle in one hand, perhaps consisting of a number of flat boards struck together when rattled, and another flat percussion instrument in his other hand and on his knees.

(2) A similar scene is found in an Old-Akkadian cylinder seal (fig. 2).[3] Two musicians are seated in front of a deity. The musician in front plays the lyre,

*Sumerian words are given in italics when they refer to their pronunciation and not to the sign with which they are written.

and the musician at the back holds – like the jackal or fox in the previous scene – a rattle, again perhaps made of flat boards, in one hand, and a flat percussion instrument on his knee.

(3) A stone bowl from Neo-Assyrian Nimrud (fig. 3)[4] depicts a figure with a tall hat holding a rattle, similar to the instruments in the previous scenes, in his right hand, and the same flat percussion instrument in his left hand. Here this instrument seems to consist of two parallel parts.

(4) A seal impression from Seleucid Uruk (fig. 4)[5] depicts a seated person holding a sistrum in one hand and probably the flat percussion instrument on his knee. Here the sistrum is similar to the Egyptian sistrum and to sistra known from Anatolia, consisting of rings on crossbars which produce sounds when rattled.[6]

(5) An almost identical scene is probably found on two Late-Babylonian stamp seal impressions (perhaps of the same seal) from Ur (figs 5 and 6).[7] The figure is seated on the same type of chair as in the previous scene, and may be holding a sistrum in one hand and the same flat object on his knee. Here, the handle of the sistrum seems to be square, at least on one of the impressions.

The Setting of the Sistrum in Context of the gala/*kalû*-singer

Thus, we have five representations, two from the third millennium B.C. and three from the first millennium B.C., where we find a figure, usually seated, playing two musical instruments: a rattle or sistrum and a flat percussion instrument. In the two scenes from the third millennium, the playing of this pair of instruments is accompanied by a lyre.

A further investigation of the scenes may help identify these instruments, especially by considering their cultic environment. This can be done by attempting to identity the player of the rattle or sistrum and the other percussion instrument in the scenes.

We are lucky enough to be able to identify two of the figures from the first millennium B.C. objects. The Nimrud bowl bears an inscription, identifying the cultic profession of the figure depicted on it: *kalamāḫu*.[8] Similarly, we know the name of the owner of the seal from Seleucid Uruk: Riḫât-Anu, son of Anu-iqīšannu, descendant of Sîn-lēqi-unninni, who was active in Uruk between 58-67 of the Seleucid Era, that is, during the middle of the third century B.C. Like other members of the Sîn-lēqi-unninni family in Late-Babylonian Uruk, Riḫât-Anu was most probably a *kalû* or even a chief *kalû*: *kalamāḫu*. In fact, the *kalamāḫu* Anu-aḫ-ittannu, son of Riḫât-Anu, known from a colophon and from several archival texts dating to 68-73 of the Seleucid Era, may very well have been the son of the owner of our seal.[9]

Thus, in at least two of the scenes, we know that we are dealing with the *kalû*, or chief *kalû - kalamāḫu*-profession. Therefore, let us now take a closer look at the *kalû*, and after encountering this cultic figure, we shall return to our sistrum.

The *kalû* (Sumerian: gala) is known to have been a performer of prayers in the Emesal form of Sumerian, from the third millennium B.C. until the end of the first millennium B.C. These prayers played an important role in the religion of ancient Mesopotamia. The association of the gala/*kalû* with the Emesal prayers was so close that these prayers were grouped together in the first millennium under the term *kalûtu*. There are many indications that the gala or *kalû* sang some of the genres of the Emesal prayers, especially the balaĝ and eršema genres, and that the singing of these prayers was accompanied by musical instruments. The close association of the performance of these prayers to their musical accompaniment is also seen in the names of the genres balaĝ and eršema, named after musical instruments, namely, the balaĝ and šèm instruments.

The Musical Instruments of the gala/*kalû*-singer

We know of at least five musical instruments which accompanied the performance of Emesal prayers: balaĝ, li-li-ìs, ùb, šèm, and me-zé. These instruments are listed together in a passage from a balaĝ prayer describing the musical performance of the gala:[10]

'The gala sings a song for him,
The gala sings a song of lordship for him,
The [gala] (sings) a song with the balaĝ for (him),
He (plays) the holy *ub* and the holy *lilis*-drum (for him),
He (plays) the *šem, meze* and holy balaĝ (for him)'.

The five instruments listed in this passage are the five instruments which are most closely associated with the gala/*kalû* in other texts as well.[11] Are we able to identify these instruments?[12]

The *lilissu* was a large kettle-drum. A drawing of a kettle-drum is labeled: ᵈlilis, 'divine *lilissu*,' in a tablet commenting on the *lilissu* ritual copied in Nippur, but most probably found in Seleucid Uruk.[13] The *lilissu* is most probably represented in two seal impressions from Seleucid Uruk belonging to Anu-iqīšannu, son of Širki-Anu, descendant of Sîn-lēqi-unninni, who was most likely a *kalû*, active in Uruk during the years 16-50 of the Seleucid Era, that is, the first half of the third century B.C. This individual is the father of Riḫât-Anu, the owner of the seal portraying the sistrum player discussed earlier.[14]

The *ùb* seems to have been a kettle-drum covered with a leather head, as seen from the determinative KUŠ, 'leather', often appearing with it. It is often compared to the *lilissu* in literary and lexical texts.[15]

The identification of the balaĝ has been disputed

for many years. There is some evidence that the balaĝ was a stringed instrument and other evidence that it was a drum. As I have demonstrated elsewhere, the balaĝ was certainly a stringed instrument in the third millennium B.C., specifically, a lyre, and from the second millennium B.C. onwards the term began to designate the *lilissu*-drum which replaced the balaĝ-lyre in the accompaniment of the balaĝ-prayers.[16]

We are left with two instruments: šèm and me-zé. These two instruments are closely associated: they often appear together in cuneiform texts,[17] they can even be written with the same sign in the first millennium,[18] and variant texts may replace one with the other.[19] One might even suspect that in early references, the sign for *šem* may have sometimes been read as *meze*.[20]

The *šèm*, Akkadian *ḫalḫallatu* was the main instrument which accompanied the eršema genre. What was this *šèm*? I believe it was a small percussion instrument, at times perhaps consisting of two parts which were struck together.

In my opinion there is an iconographical representation of the *šèm* in a Gudea stela, paralleled by the Ur-Namma stela.[21] In the Gudea cylinders we read of the rituals and celebrations which were performed during the building of the Eninnu temple. This description of the building of Eninnu mentions four instruments: the balaĝ, the *šem* (written si-im), the á-lá and the *adab* (written: a-dab₆). Most occurrences refer to the playing of the á-lá and the *šem*, and occasionally also the *adab*, during the rituals for the building of the temple.[22]

The Gudea stela fragments include the representation of two musical instruments: a giant drum and cymbals. Since it is likely that these instruments are to be identified with some of the instruments mentioned in the inscription, this led several scholars to identify the giant drum seen in the Gudea stela fragments and elsewhere as the balaĝ instrument. However, in my opinion such an identification is mistaken, and the giant drum is to be identified as the á-lá.[23]

This leaves us with the identification of the other instrument in the stela: the cymbals. Looking again at the four instruments mentioned in the Gudea inscriptions, balaĝ, á-lá, *šem* (si-im) and *adab* (a-dab₆), let us proceed by elimination. The cymbals are not the á-lá, which in my opinion is the giant drum. They are not the balaĝ either, which, as mentioned earlier, was a stringed instrument and not a percussion instrument, at least in this period, and could therefore not be identified as the cymbals. We are left with two options: *adab* and *šem*. Since the *šem* is often attested with á-lá in the Gudea cylinders and elsewhere,[24] I propose that these cymbals are the *šem*, or less likely the *adab*, which I will mention again later.

However, these instruments, the á-lá, *adab* and *šem*, mentioned in Gudea, do not belong to the repertoire of

the gala, but rather to another cultic singer, the nar. There are two parallel categories of cultic musical instruments in ancient Mesopotamia, those which belong to the nar, and those which belong to the gala.[25] The *šem* instrument is shared by these two categories. In my opinion, originally, we may assume that the nature of this *šem* was identical in the two groups, but perhaps with time, it went through different processes of change and evolution within the different categories. Therefore, while I believe that the cymbals in the Gudea stela are probably the *šem* of the nar, they were not necessarily identical to the *šem* of the gala with which we are dealing. Still, I believe that the *šem* of the gala, or later the *ḫalḫallatu* of the *kalû*, shared its general nature with the *šem* of the nar, and thus was a small percussion instrument, perhaps consisting of two parts struck together, as were the cymbals of the nar. But what exactly was this *šèm* of the gala?

Identification of the Instruments in the Iconographical Representations

Now, at last, let us return to the iconographical scenes discussed earlier. As mentioned, the figure holding the rattle or the sistrum and the flat percussion instrument in two of the first millennium B.C. scenes was a *kalû* or *kalamāḫu* (figs 3 and 4). Though no inscription accompanies the bullae of the musicians from Late-Babylonian Ur (figs 5 and 6), it would not be surprising if this figure would turn out to be a *kalû* as well.

In both third millennium objects there is also reason to believe that the context of the musical scenes is connected to the repertoire of the gala (although this cannot be proven).

The entire scene of the animals playing musical instruments (fig. 1), coming from the royal tombs of Ur, is in keeping with the funerary role of the gala and the balaĝ instrument known from the third and perhaps also second millennium B.C.[26] In fact, in my opinion, the bull-based lyre is the balaĝ-instrument itself, known to be so closely associated with the gala.[27] We may assume that the two instruments, the rattle and the flat square percussion instrument held by the small animal, are instruments related to the gala as well.

Regarding the Old-Akkadian cylinder seal (fig. 2), Boehmer already observed that the deity in front of whom the musicians are playing is the raging battle goddess Inanna.[28] The musical performance is therefore intended to soothe Inanna's raging heart, which is the exact role of the performance of Emesal prayers in their musical context, and thus it is not unlikely that the scene may belong to the world of the gala as well.

Now what could these two instruments found in the context of the gala/*kalû* be? Well, first we may guess what they are not. They are not the *lilissu* or *ùb*, which are kettle drums. The *ùb* probably did not even exist after

the third millennium B.C., and is only attested in later literary and lexical texts, and so this excludes its appearance in the late scenes. The sistrum or rattle and the percussion instrument are not the balaĝ either, which is a lyre. We are left with me-zé, or Akkadian *manzû* and šèm, Akkadian *ḫalḫallatu*, which, as discussed above, are also associated together in many textual sources, and would therefore be in keeping with the iconographical pairing of the sistrum or rattle and the other percussion instrument. Thus, I believe it is quite safe to assume that these two instruments are the me-zé and the šèm. It is more difficult to ascertain which of these instruments is the šèm and which is the me-zé.

Now, I would like to suggest cautiously that the rattle or sistrum is the me-zé /*manzû* and that the other percussion instrument is the šèm/*ḫalḫallatu*. Now, I already suggested that the cymbals of the Gudea stela may be identified as the *šem*, but those of the nar and not of the gala. As seen in the Nimrud representation of the *kalamaḫu* (fig. 3), the square instrument he holds seems to consist of two boards, perhaps struck together. Although this is not identical to the cymbals in the Gudea stela, it is a similar instrument. In the other scenes it may represent a type of frame drum.[29] Unfortunately, I am unable to identify more about the nature of this instrument. Whatever this instrument may be, I suggest it is the šèm/*ḫalḫallatu* instrument in the repertoire of the gala/*kalû*.

This leaves us with the rattle or sistrum, the subject of this paper. On the basis of the identical word me-zé, 'jaw', Konrad Volk raised the possibility that the me-zé instrument was a sound-stick, resembling the shape of a jawbone.[30] The association of the me-zé instrument, or Akkadian *manzû*, with me-zé, the jawbone, also existed in antiquity: In a ritual commentary from Assur, the *manzû* is explained as the lower jaw of a god.[31] We may also mention here that jawbones of horses, mules and donkeys are known to be used as rattles in American culture, where the jaw-bone is struck, causing the teeth to rattle.[32] Such a jaw-bone rattle could have been the origin of the instrument which later developed into a rattling sistrum. In addition, the characteristic U-shape of this instrument in all five iconographical representations, may resemble the arched shape of the bottom jaw of an animal. Thus, we may cautiously assume that the sistrum or rattle is the me-zé/*manzû*. It is here worth mentioning that I suspect that the *adab*, belonging to the repertoire of the nar, is a kind of rattle, the counterpart of the me-zé of the gala. This is supported by a lexical commentary entry from the first millennium, which equates the *adab*-instrument with the *manzû*.[33]

Since the evidence for the identification is not certain, there is still a possibility of the opposite, that the rattle or sistrum is the šèm/*ḫalḫallatu* and the flat percussion instrument – the me-zé/*manzû*.

This may be supported by the etymology of the word *ḫalḫallatu*. This word may perhaps be connected to the verb *ḫiālu*, 'to tremble, writhe', reflected in the Hebrew verb *ḥīl*, 'to shake', and the noun *ḥalḥālāh*, 'shaking, trembling', which uses the base *ḥlḥl* as in Akkadian *ḫalḫallatu*.[34] Such an etymology would fit a rattle or sistrum, played by shaking,[35] and thus the other percussion instrument would be the me-zé/*manzû*. If so, perhaps the cymbals in the Gudea stela should not be identified as the *šem* of the nar but rather as the remaining option: *adab*.

In any case, as mentioned above, in my opinion it is quite safe to identify the two instruments found in all five scenes as representations of the *šèm*/*ḫalḫallatu* and the me-zé/*manzû*.

Excursus: Possible Etymology of me-zé/*manzû*

Below are some considerations regarding the etymology of the word me-zé/*manzû*. Needless to say, these arguments are entirely hypothetical.

As discussed above, the me-zé instrument may be connected to me-zé, 'jaw-bone'. If so, the following etymological procedure may have occurred: Alongside the form *meze*, a form **(w)eze* may have existed in Early Dynastic periods, perhaps meaning 'jaw'.[36] This form is probably found in the compound verb ÁB+ŠÀ+GI… dab$_5$, perhaps: 'to hold the jaw', as an expression for some kind of negative feeling.[37] The pronunciation **(w)eze* gave rise to the syllabic reading of the sign ÁB+ŠÀ+GI as ze$_x$.[38] This pronunciation may also be reflected in the Akkadian word *is(s)u*, 'jaw', which I assume should be connected etymologically to Sumerian **(w)eze* (< *meze*) (though the direction of borrowing is not clear).[39] Since the sign is very similar to the sign representing the *šem* instrument in the Early Dynastic period (ÁB+ŠÀ; see n. 20 above), it is possible that **(w)eze* was already associated with the musical instrument in this period, though there are no clear textual indications for this.[40]

The form *meze* existed as well, found in later texts as the word for jaw and as the word for the musical instrument, written: me-zé. This pronunciation is reflected in the Akkadian word for the musical instrument: *manzû* (or *manṣû*).

It is assumed that both words written me-zé, *i.e.*, 'jaw-bone' and the musical instrument, are etymologically connected (perhaps through the material from which the instrument was originally made, see above), but it is also possible that these are two different homonymic words, which may have been associated together already in antiquity.[41]

Notes

1 *Cf., e.g.*, Hickmann H. (1961-Leipzig) *Ägypten*, Musikgeschichte in Bildern, II/1: 48-51.

2 Woolley, C.L. (1934-London-Philadelphia) *The Royal Cemetery*, Ur Excavations, II: pl. 105.

3 Boehmer, R.M. (1965-Berlin) Die Entwicklung der Glyptik Während der Akkad-Zeit, *Untersuchungen zur Assyriologie und Vorderasiatischen Archäologie* 4: Pl. XXXII, no. 385.

4 Mallowan, M.E. (1966-London) *Nimrud and its Remains I:* 270 no. 251.

5 Wallenfells, R. (1994-Mainz) *Uruk Hellenistic Seal Impressions in the Yale Babylonian Collection I. Cuneiform Tablets*, Ausgrabungen in Uruk-Warka Endberichte 19: 21 and pl. 4, no. 53.

6 For Egyptian examples, see reference in n. 1 above; for Anatolia, *cf.* Akurgal E. (1962-London) *The Art of the Hittites*: pl.12 (reference: T. Ornan).

7 Legrain, L. (1951-London-Philadelphia) *Seal Cylinders*, Ur Excavations X: Pl. 40, nos 740-1.

8 Mallowan, *Nimrud and Its Remains*, I: 270, no. 251:2: LÚ.UŠ. KU.MAḪ.

9 Wallenfels, ed. (2000-Münster) *Uruk Hellenistic Seal Impressions*: 20; Beaulieu, P.-A., 'The Decendants of Sîn-leqi-unninni', in Marzahn J. and H. Neumann (eds.), *Assyriologica et Semitica: Festschrift für Joachim Oelsner*, Alter Orient und Altes Testament 252: 11-2.

10 Cohen, M.E. (1988-Potomac) *The Canonical Lamentations of Ancient Mesopotamia*, II: 420a+37-41.

11 Most of these instruments are grouped together in the context of the performance of Emesal prayers, usually by the gala, also in the following references: Cooper, J.S. (1983-Baltimore-London) *The Curse of Agade:* 89-90:200-1; Cohen, M.E. (1981-Cincinnati) *Sumerian Hymnology: The Eršemma*, Hebrew Union College Annual Supplements 2: 104:17-23; Cavigneaux, A. (1987) Notes Sumérologiques, *Acta Sumerologica* 9:62:7-10; Radau, H. (1913-München) *Sumerian Hymns and Prayers*, The Babylonian Expedition of the University of Pennsylvania, Series A: Cuneiform Texts, XXX/1: Pl. 16, no. 9, r. iii: 4-10.

12 A full treatment of these instruments is found in Gabbay, U. (2007-Jerusalem) *The Sumero-Akkadian Prayer 'Eršema': A Philological and Religious Analysis*, unpublished dissertation: 45-100.

13 Thureau-Dangin, F. (1911-Paris) *Tablettes d'Uruk à l'usage des prêtres du Temple d'Anu au temps des Séleucides*, Musée du Louvre – Département des antiquités orientales. Texts cunéiformes, VI: pl. XCI.

14 Wallenfels, *Uruk Hellenistic Seal Impressions:* 19-20, nos. 51-52.

15 The relation between the *lilissu* and *ùb* instruments will be discussed by me elsewhere. *Cf.*, provisionally the following references: Falkenstein, A. (1939) 'Untersuchungen zur sumerischen Grammatik', *Zeitschrift für Assyriologie*, 45: 171, n.1, v:15; Landsberger, B. (1959-Rome) *The Series ḪAR-ra=ḫubullu*, Tablets VIII-XII, Materialen zum Sumerischen Lexikon 7: 153:190; Civil, M. (1979-Rome) *Ea A = nâqu, Aa A = nâqu, with Their Forerunners and Related Texts*, Materials for the Sumerian Lexicon, 14: 506:2.

16 Gabbay, U., 'The Balaǧ Instrument and Its Role in the Cult of Ancient Mesopotamia', in Goodnick Westenholz J., E. Seroussi and Y. Maurey (eds.), *Sounds from the Past: Music in the Ancient Near East and Mediterranean Worlds*, (Yuval Studies, Jerusalem).

17 *Cf.* references in Oppenheim A.L. and Reiner E. (eds.) (1977-Chicago-Glückstandt) *The Assyrian Dictionary of the Oriental Institute of the University of Chicago*, 10, M/I: 239; *cf.*, also Farber-Flügge G. (1973-Rome) *Der Mythos 'Inanna und Enki' unter besonderer Berücksichtigung der Lister der me*, Studia Pohl 10: 60, II, vi: 24; Langdon, S. (1913-Paris) *Babylonian Liturgies*: pl. XLVIII, no. 47:5'; Beckman G. and B.R. Foster (1988-Philadelphia) 'Assyrian Scholarly Texts in the Yale Babylonian Collection', in Leichty E.; Ellis, M. deJ. and Gerardi, P., (eds) *A Scientific Humanist: Studies in Memory of Abraham Sachs*: 23, no. 21:10,

cf., Farber W., Review of F.A.M. Wiggermann (1996) Mesopotamian Protective Spirits: The Ritual Texts, *Journal of the American Oriental Society* 116: 265. Though it is sometimes difficult to ascertain whether to read the sign ÁBxŠÀ as šèm or ùb, when this sign appears with me-zé, it is probable that it should be read as šèm; *cf.,* however Maul, S.M. (1988-Wiesbaden) Herzberuhigungsklagen: Die *sumerisch-akkadischen Eršahunga-Gebete:* 75:22 [k]uš²ub me-zé.

18 ÁBxME.EN = meze, šem₄. This led to some confusion in modern transliterations of texts, especially from Seleucid Uruk, where the sign ÁBxME.EN should usually be read šem₄ and not meze.

19 See Cooper, *The Curse of Agade:* 190:201; Volk K. (1989-Stuttgart) *Die Balağ-Komposition úru àm-ma-ir-ra-bi: Rekonstruktion und Bearbeitung der Tafeln 18 (19' ff.), 19, 20 und 21 der späten, kanonischen Version,* Freiburger Altorientalishce Studien 18 : 29.

20 In the orthography of the third millennium BC, I assume that the sign ÁB+TAK₄ refers to the *ub* instrument (=ub₅); *cf.* Selz G., The holy drum, the spear, and the harp: Towards an understanding of the problems of deification in third millennium Mesopotamia, in Finkel, I.L. and Geller, M.J. (eds) (1997-Groningen) *Sumerian Gods and Their Representations* Cuneiform Monographs 7. . And *contra* Krispijn, Th.J.H., (2002-Rahden) "Musik in Keilschrift: Beiträge zur altorientalischen" *Musikforschung* 2, in Hickmann E., A.D. Kilmer and R. Eichmann (eds.) *Studien zur Musikarchäologie III,* Orient Archäologie, 10: 467 with no. 7, who read the sign as šem₆. However, the sign ÁB+ŠÀ may refer to the šem-instrument (= šèm), see Selz, The holy drum: 172 and 193, n.113 (but contra Selz's reading of the signs as ùb). Krispijn, Musik in Keilschrift: 467, no. 7, identifies the sign ÁB+ŠÀ+GI as meze$_x$, representing the musical instrument. However, this interpretation is uncertain (see no. 40 below).

21 For reconstructions of these stelae, *cf.* Suter, C.E. (2000-Groningen) *Gudea's Temple Buiding: The Representation of an Early Mesopotamian Ruler in Text and Image,* Cuneiform Monographs, 17 : 170-6, 244-9, pl. B.

22 See Edzard, D.O. (1997-Toronto) *Gudea and His Dynasty,* The Royal Inscriptions of Mesopotamia, Early Periods, 3/1: 80, cyl. A, xviii:18; p. 87, cyl. A, xxviii:18; p. 97, cyl. B, xv: 20.

23 See Mirelman, S., in: *Sounds from the Past* (forthcoming).

24 *Cf.,* references in Sjöberg, A.W. (ed.) *The Sumerian Dictionary of the University Museum of the University of Pennsylvania* 1, A/II: 81a.

25 See Shehata, D., in *Sounds from the Past* (forthcoming).

26 *Cf.,* Cooper, J.S. (2006) Genre, Gender and the Sumerian Lamentation, *Journal of Cuneiform Studies,* 58: 42; Tanret M. and K. Van Lerberghe (1993-Leuven) Rituals and Profits in the Ur-Utu Archive, in Quaegebeur J. (ed.) Ritual and Sacrifice in the Ancient Near East *Orientalia Lovaniensia Analecta* 55: 436-37; *cf.,* also Civil, M. (ed.) (1969-Rome) *The Series lú = šá and Related Texts* Materials for the Sumerian Lexicon, XII: 102:183 and 120: 7': lú-balağ-ğá=*mu-še-lu-ú e-ţim-me,* 'he of the balağ=raiser of spirits'.

27 See Gabbay, 'The balağ instrument' (forthcoming).

28 Boehmer, *Die Entwicklung der Glyptik*: 119.

29 For previous views on the identity of this instrument in the third millennium BC representations, *cf.* references in Rashid S.A. (1984-Leipzig) *Mesopotamien,* Musikgeschicte in Bildern, II/2: 40.

30 Volk, Die balağ-Komposition: 101.

31 See Livingstone A. (1989-Helsinki) *Court Poetry and Literary Miscellenea,* State Archives of Assyria, 3: 99, no. 39: 8.

32 See Randel, D.M. (1986) *The New Harvard Dictionary of Music:* 413.

33 Landsberger, *Materials for the Sumerian Lexicon,* VII: 153-93.

34 Koehler L. and Baumgartner, W., subsequently revised by Baumgartner, W. and Stamm, J.J., translated and edited under the supervision of M.E.J. Richardson (1994-2000-Leiden-Boston-Köln) *The Hebrew and Aramaic Lexicon of the Old Testament.* Vol. I: 310-1, 318. The same is found in Arabic, *cf.,* Lane, E.W. (1863-1893-London-Edinburgh) *An Arabic-English Lexicon.* Vol. 2: 781b.

35 Note that the word sistrum is derived from the Greek verb *seio,* 'to shake'.

36 For the loss of initial 'm' in Sumerian (though before the labial vowel 'u'), *cf.,* Geller, M.J. (2000) A problem in Sumerian phonology, *Acta Sumerologica,* 22: 77 (perhaps reflecting m > w).

37 See Frayne, D.R. (2008-Toronto) *Presargonic Period (2700-2350)* The Royal Inscriptions of Mesopotamia, Early Periods 1: 131, vii: 4 ('being angry'). Note that body parts are common as the nominal part of compound verbs. However, one cannot exclude the possibility that ze$_x$(ÁB+ŠÀ+GI) stands here for 'gall,' written 'zé' in later periods.

38 See Krecher J. (1995-Neukirchen-Vluyn) Die *marû*-Formen des sumerischen Verbums, in Dietrich M. and Loretz, O. (eds.), *Vom Alten Orient zum Alten Testament: Festschrift für Wolfram Freiherrn von Soden zum 85. Geburtstag am 19 Juni 1993,* Alter Orient und Altes Testament, 240 : 189, n.99; *cf.,* Frayne, *Presargonic Period:* 127.

39 I assume that the origin of the word is Semitic, borrowed into Sumerian, but perhaps re-loaned back into Akkadian in the form *is(s)u.* For an Arabic etymology of *meze,* 'jaw', namely the Arabic root *mḏġ,* 'to chew', *cf.,* Holma, H. (1911-Leipzig) *Die Namen der Körperteile im Assyrisch-Babylonischen: Eine lexikalisch-etymologisch Studie:* 31; Lane, *Arabic-English Lexicon,* vol.8, (supp.): 3021b; Hava J.G. (1970-Beirut) Al-Faraid *Arabic-English Lexicon:* 724b.

40 In my opinion it is unlikely that the personal name a-ÁB+ŠÀ+GI-ÁB+ŠÀ+GI should be interpreted as a-meze$_x$-meze$_x$, 'Der Vater … bei den Tamburinen' (see Krispijn, Musik in Keilschrift: 467 with no. 7). Rather, the sign ÁB+ŠÀ+GI is probably to be understood here syllabically, standing for a-ze$_x$-ze$_x$, *cf.* the personal name a-zi-zi in the Ur-III period, Limet, H. (1968-Paris) *L'anthroponymie sumérienne dans les documents de la 3ème dynastie d'Ur:* 381. Similarly, the personal name ÁB+ŠÀ+GI-na is to be interpreted as ze$_x$-na, paralleled by contemporary zi-na, see Krecher, 'Die *marû*-Formen': 189, no. 99.

41 If so, it is possible that the Akkadian *manzû* (or *manṣû*) instrument is not to be etymologically connected to Arabic *mḏġ,* 'to chew' (see no. 39 above), but rather to the Hebrew musical term found in Biblical Psalms:*l-mnṣḫ, cf.* Holma, H. (1914) Lexikalische Miszellen, *Zeitschrift für Assyriologie,* 28: 160-1.
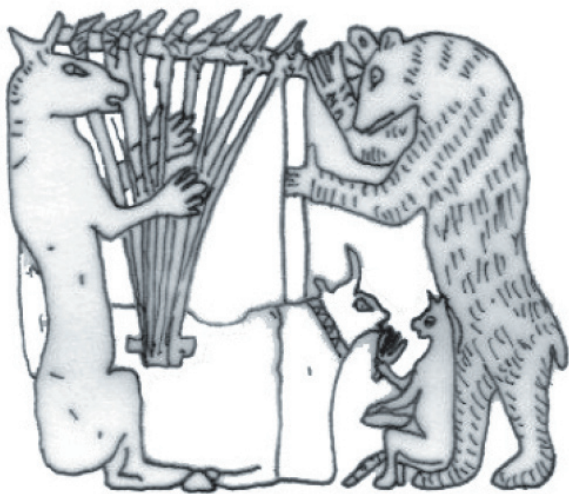
Illustrations

Fig. 1. Drawing according to photograph in Wooley, C.L., *The Royal Cemetery,* Ur Excavations, II, (1934-London-Philadelphia): pl. 105.

Fig. 2. Drawing according to photograph in Boehmer, R.M., *Die Entwicklung der Glyptik Während der Akkad-Zeit.*Untersuchungen zur Assyriologie und Vorderasiatischen Archäologie, 4, (1965-Berlin): pl. XXXII, no. 385.

Fig. 3. Drawing according to photograph in Mallowan, M.E., Nimrud and its Remains, I, (1966-London): 270, no. 251.

Fig. 4. Drawing according to photograph in Wallenfells, R, *Uruk Hellenistic Seal Impressions in the Yale Babylonian Collection I. Cuneiform Tablets*, (1994-Mainz-Ausgrabungen in Uruk-Warka Endberichte, 19): pl. 4, no. 53.

Figs. 5-6. Drawings according to photographs in Legrain, L., *Seal Cylinders*, Ur Excavations X (1951-London-Philadelphia): pl. 40, nos 740-1.

MUSICAL RECONSTRUCTION OF THE HURRIAN MATERIAL BY STATISTICAL ANALYSIS

David Halperin

For nearly forty years musicologists, together with scholars from other fields, have wrestled with the problem of deciphering the musical notations found in tablets found in excavations of the Royal Palace of Ugarit, present-day Ras Shamra, in northern Syria.

These tablets are mostly fragmentary; only one of them, known as H.6, is more or less complete after a few pieces have been matched and joined. This one has a cuneiform literary text in Hurrian, imperfectly understood but apparently recording a hymn to a local goddess, written in the upper half of the tablet, and cuneiform words representing music written below (these will here be called note-words). The other fragments, not part of H.6, share the same format but are too small to provide anything like complete phrase, textual or musical. The pertinent musical lines of H.6 are:

The note-words: lines 5-11 of H.6 (=RS 15.30 +15.49 + 17.387)

5.   *qablite 3 irbute 1 qablite 3 šaḫri 1 titimišarte 10 uštamari*

6.   *titimišarte 2 zirte 1 šaḫri 2 šaššate 2 irbute 2*

7.   *embube 1 šaššate 2 irbute1 nidqabli 1 titar qabli 1 titimišarte 4*

8.   *zirte 1 šaḫri 1 šaššate 4 irbute nidqabli 1 šaḫri 1*

9.   *šaššate 4 šaḫri 1 šaššate 2 šaḫri 1 šaššate 2 irbute 2*

10.   *kitme 1 qablite 3 kitme 1 qablite 4 kitme 1 qablite 2*

11*.   *annu zammarum sa nidqibli zaluzi ... SU ᵐ Ammurabi*

* Line 11 is apparently a colophon, giving the scribe's name and possibly specifying a mode.

The identification of the note-words on both lower halves of the tablet as musical notation rests on the affinity of these words with terms known from Mesopotamian texts concerning musical theory. One of these, CBS 10996, from Nippur, contains the lines listed below, with the parallel Ugaritic terms listed for comparison.

Comparison of Mesopotamian and Hurrian Terms

	CBS 10996	Hurrian Texts
1-5	*nīš* GABA.RI*	*nīš* GABA.RI*
7-5	*šerum*	*šaḫri*
2-6	*išartum*	*<išarte>*
1-6	*šalšatum*	*šaššate*
3-7	*embūbum*	*um/embube*
2-7	*rebūtum*	*irbute*
4-1	*nīd qabli*	*nitqibli/natqabli*
1-3	*išqum*	*ešgi*
5-2	*qablītum*	*qablite*
2-4	*titur qablītum*	*titar qabli*
6-3	*kitmum*	*kitme*
3-5	*titur išartum*	*titimišarte*
7-4	*pītum*	
4-6	*serdum*	*zirte*

* Now to be read *niš tuḫrim* (see Krispijn/Mirelamn, *Iraq*, forthcoming). The pseudo ideogram GABA.RI, in logographic rather than syllabic writing, appears in the Hurrian fragments once or possibly three times (the readings are uncertain); a form of *išartum* may appear once; no form of *pītum* is known.

The Babylonian terms refer to pairs of strings, or to pairs of notes, or to modes, or to runs of consecutive notes, or perhaps to something else. Reference to the meanings of the Babylonian terms for the purpose of deciphering the music of H.6 has served until now for most of the assaults on the Ugaritic material. But the survival of terms is hardly a guarantee of the survival of their applications and meanings: the word 'alto' once meant a voice higher than the melody; later, and still today, the lowest female voice; nowadays it can also refer to a particular size of saxophone.

Decipherment is essentially a problem in cryptanalysis, and successful cryptanalysis often depends on statistical methods. Some assumptions derived in part from extratextual knowledge must of course be made; following are the assumptions used in the present analysis:

- Each note-word corresponds to a musical pitch (or perhaps to a string of an instrument; for the method I propose there is no difference).
- The numbers intercalated between the note-words do not affect the scale order of the pitches.
- The word *uštamari* at the end of line 5 is not a note-word.
- The literary texts found in the tablets, while undoubtedly connected with the music, may be ignored for the present purpose.

- The melodies formed by the successions of note-words tend to proceed conjunctly rather than disjunctly – by steps rather than by leaps (or, in musicological jargon, *spissim* rather than *saltatim*).

This last assumption is central to the procedure now described:

1. All successions of two or more note-words are read from all of the tablets and fragments, and are tabulated in a two-dimensional array (see table below), where the indices are the individual note-words and the cell values are the numbers of instances of adjacency for each pair of note-words. No instances were found where a note-word is immediately repeated.

2. The ordered list of note-words (encoded in the table as letters) is taken as showing the 'distances' between the members of each pair. In the table below, for example, with the arbitrary order ABCDEFGHIJK, the distance between *titarkabli* and *zirte* is 2; between *zirte* and *irbute* is 1; and so on.

3. Each distance is then multiplied by the number of instances of the corresponding adjacent pair, and the sum of these products is considered as a measure of disjunctiveness for the permutation or order being tested.

4. The list formed arbitrarily in step 2 is now subjected to all possible permutations, and for each permutation the operation of step 3 is performed.

5. Finally, that permutation with the smallest measure of disjunctiveness is taken to represent the order of pitches in the Ugaritic scale.

Adjacency matrix with working codes for note-words

Note-word		Code	A	B	C	D	E	F	G	H	I	J	K
natqabli	=	A	-	3	2	0	0	4	0	2	0	0	0
šaḫri	=	B		-	0	0	12	1	0	0	0	8	1
titar qabli	=	C			-	5	0	0	0	2	1	1	0
titimišarte	=	D				-	4	0	0	0	0	1	0
zirte	=	E					-	1	0	0	0	0	0
irbute	=	F						-	3	0	1	11	4
qablite	=	G							-	1	5	0	0
ešgi	=	H								-	0	0	0
kitme	=	I									-	0	0

This procedure is clearly a 'brute-force' method for what is called seriation or ordination. There exist sophisticated algorithms for carrying out seriation, but these would not serve and indeed are not needed in the present case.

There is of course more than one way of measuring 'distances'. The simple, or linear, metric first used was replaced by two others – the squares and cubes of the ordinal differences – for comparison at a later stage. But as only 75 pairs of note-words were unmistakably legible, the statistical reliability of the results is weakened, even with the use of multiple metrics.

The results of the seriation procedures are:

Permutation*	s(linear)	s^2(quadratic)	s^3(cubic)**	Total $s+s^2+s^3$
AFKJBEDCHIG	123	271	765	1159
ADCHIGKFJBE	124	276	796	1196
AFKJBEDCHIG	124	292	796	1212
ACDEBJKFGIH	123	277	813	1213
ACHIGKFJBED	124	298	974	1396
ACHIGKFJBED	124	320	962	1406

*As the order is assumed to be cyclic, all permutations are listed as beginning with A (*natkabli*); this is only for the sake of convenience.

**The 'quadratic' column is that obtained using the squares of the 'distances'; 'cubic' uses their cubes.

For now, we take the first row as representing the optimal arrangement of the note-words and therefore the scale they form (later we shall emend this judgment). But note that some runs of letters recur in the rows above: CHIG in rows 1, 2, 3, 5 and 6; BED in 1, 3, 5 and 6; and K F and J are together in all rows, though not in the same order.

Before applying these results to the music of H.6, let us list what hasn't been found:

- Only the order of the pitches in the scale has been found, not the direction. In other words, the scale may be either ascending or descending, and the procedure provides no way of deciding.
- The absolute intervals between successive pitches remain unknown; the scale may be diatonic or chromatic or something else.
- No absolute pitch will emerge from the procedure.
- No rhythmic interpretation is considered or suggested.

Although there are good reasons to believe that we are dealing with vocal rather than instrumental music, the procedure is actually independent of the performance medium. With these caveats in mind, let us now suggest a melody for H.6, using the first row of the table of results. First, let's substitute the note-names for the alphabet code used in the procedure:

A	F	K	J	B	E	D	C	H	I	G
natqabli	*irbute*	*embube*	*sassate*	*saḫri*	*zirte*	*titimišarte*	*titar qabli*	*ešgi*	*kitme*	*qablite*

Now, taking *kitme* (letter I) as the lowest note (the reasons for this will be explained presently) and plotting the notes on a staff, we get the following:

I G A F K J B E D

And using this as the scale for transcription, a possible notation for H.6 will be:

G F G   B D ? D E B J F K J F A

C D E B J F A   B J B J B J F

I G I G I G
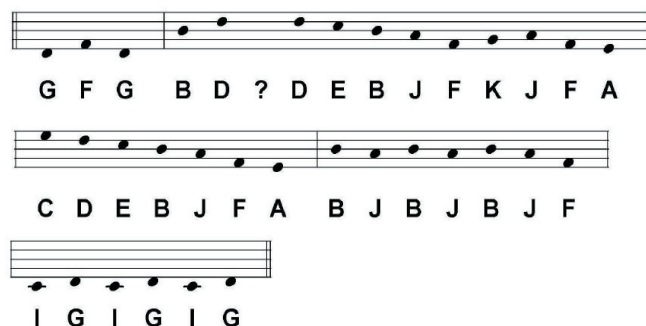
I can only speculate on the significance of *uštamari*, shown as an interrogation mark in the transcriptions. As it stands between two occurrences of the same note-word - there are no cases of a note-word's immediate repetition - it may signify tacet, a rest; or possibly it indicates some kind of ornamentation of the melody; or perhaps, what seems to me more likely, it is a sign to change the performance, as from instrumental to vocal: one suggested translation of the word, 'not to sing', may imply this.

A choice had to be made between a rising and a falling scale. The direction used here is that which gives the melody a mainly descending character, which is rather characteristic (albeit not universally so) of melodies in general. I decided to break the cycle at letter I from considerations of melodic coherence.

The use of staff lines should not be taken to imply certain musical intervals in the note successions, and the absence of a clef sign is deliberate. The barring shown here reflects my intuitive view of the 'phrases' of the melody, and has nothing to do with the division into five physical lines of the musical text in the tablets.

What has been won is the scalar relation of the notes to each other: specifically, their order, and the distances between the notes measured in scale degrees (which are subject to possible inversions). If these be correct, then the general - albeit abstract - structure of the melodic line and the contour of the melody will have been established.

The results obtained by the procedure can be judged in three ways. The first of them is a critical inspection of the methodology and the assumptions and limitations which underlie it.

But when this test is passed, we are still left with a feeling of having been subjected to an arcane kind of conjuring trick, and supplementary tests are needed to make our results satisfactory.

The second way is to appeal to a subjective impression of the music of the deciphered hymn; *i.e.*, does the proposed 'melody' make 'musical sense'? Such a test, applied by most previous attempts at decipherment of the Ugaritic hymn, is hardly scientific; it substitutes intuition for analysis, and precisely this point is what motivated my research. Nevertheless, it is useful, or at least comforting, and may supplement other tests.

The third way is to refer back to the Mesopotamian theory texts and look for correspondences with our results. If found, these will not only lend support to the validity of the findings, but may also indicate a direction for future investigations of the musical (and possibly other) relations between the cultures involved. Let us now make that comparison.

The Mesopotamian text chosen for the confrontation is the previously mentioned CBS 10996. The chart of terms previously given is here reproduced in a rearranged form with its rows ordered according to the permutation used in the transcription of the hymn:

Hurrian H.6 *et al.*		CBS 10996	
		pītum	7-4
I	*kitme*	*kitmum*	6-3
G	*qablite*	*qablītum*	5-2
A	*natqabli*	*nīd qabli*	4-1
		embūbum	3-7
		išartum	2-6
		nīš GABA.RI*	1-5
F	*irbute*	*rebūtum*	7-2
K	*embube*		
J	*šaššate*	*šalšatum*	6-1
B	*šaḫri*	*šerum*	5-7
E	*zirte*	*serdum*	4-6
D	*titimišarte*	*titur išartum*	3-5
C	*titar qabli*	*titur qablītum*	2-4
H	*ešgi*	*išqum*	1-3

* Read *nīš tuḫrim*.

There are five empty cells. As was noted earlier, no parallels for Babylonian *pītum* and *išartum* are found in the Hurrian tablets, and *nīš* GABA.RI (*nīš tuḫrim*) has a special parallel, not in our hymn. The other two empty cells point to an anomaly in the placement of *umbube* vis-à-vis *embūbum*.

This anomaly will now be addressed.

It will be remembered that KF or *umbube-irbute* was one of the (almost) invariant groupings found among the first six permutations, and so their inversion or reversal will not do violence to our results. If we do indeed reverse their order, we get the permutation AKFJBEDCHIG, which has a very small disjunctiveness measure, just barely larger that that of the permutation we have used. And if we now rearrange the previous table's rows to reflect the new order, we get:

Hurrian H.6 *et al.*		CBS 10996	
		pītum	7-4
I	*kitme*	*kitmum*	6-3
G	*qablite*	*qablītum*	5-2
A	*natqabli*	*nīd qabli*	4-1
K	*embube*	*embūbum*	3-7
		išartum	2-6
		nīš GABA.RI*	1-5
F	*irbute*	*rebūtum*	7-2
K	*embube*		
J	*šaššate*	*šalšatum*	6-1
B	*šaḫri*	*šerum*	5-7
E	*zirte*	*serdum*	4-6

* Read *niš tuḫrim.*

The order of the numbers in the right-hand column is striking, and so moves us to revise our scale with K and F, *umbube* and *irbute*, changing places:

I G A K F J B E D
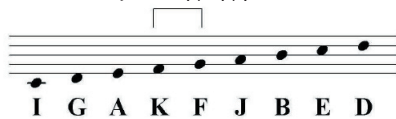
Finally, this revised scale will yield the following transcription:

G F G   B D ? D E B J F K J F A

C D E B J F A   B J B J B J F

I G I G I G
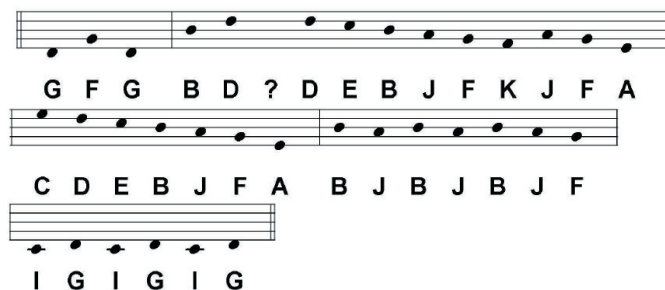
For determining the relative pitches and intervals of the scale, one is tempted to refer to the word *nidkibli* in the colophon of H.6, prescribing a musical mode, but its precise meaning is not universally agreed.

In any case, the results obtained by studying only the Hurrian materials show a striking affinity to the Mesopotamian tablet cited for comparison. This fact can be seen as a confirmation, albeit indirect, of the validity of the procedure and also of the validity of some of the assumptions underlying the analytic procedure. I see these results as constituting a first step towards deciphering the Hurrian music, and more materials, when found and published, will surely assist in furthering the project. Seriation can be a useful musicological tool for other tasks as well: One possible application is that of establishing a chronology of the works of a composer on the basis of technical characteristics found in them.

ANOTHER LOOK AT ALLEGED ANCIENT BAGPIPES

Terence Mitchell

Percy Scholes, in his widely distributed *Oxford Companion to Music*, published in 1938 but still reprinted in 1978, opens his definition of the 'Bagpipe' with the statement, 'It is said that a number of references to musical instruments in the Old Testament (however rendered by the translators) concern one or other form of bagpipe, and there are in existence Hittite carvings that definitely prove its use a thousand years before Christ'.[1]

In this paper I will seek to demonstrate that each of these assertions is incorrect, and to reinforce positions already adopted by others, largely by clarifying evidence which has been often misunderstood. I will take Scholes's two points in reverse order.

Hittite Carvings

The evidence of Hittite sculpture mentioned by Scholes was brought into the discussion early in the 20th century. It consists of a stone bas-relief of about the 14th century B.C. from Alaca Höyük (ancient name unknown), not far from the Hittite capital Hattusas in Asia Minor. There, two orthostats carved in relief show three figures pacing to the left, a lute player followed by a male figure holding an uncertain shape in front of his face, followed in turn (on an abutting slab to the right) by a man holding to his lips a different object, often taken to be a wind instrument.[2] These sculptures were examined, planned and photographed by J. Garstang in 1907,[3] and illustrated and described by him in his books *The Land of the Hittites* (1910) and *The Hittite Empire* (1929), where he refers to the site as Eyuk. In his description he interprets the right hand figure as a 'trumpeter, his instrument being a plain straight trumpet with expanding end'; and the left hand figure as playing a 'guitar'.

According to this interpretation the middle figure appears to be between two musicians, so he takes the uncertain shape held near his face to be 'an inflated skin', into which he is clearly blowing, but no pipe is represented: We must suspect a drone effect, the invariable accompaniment of Oriental music.'[4]

I have argued elsewhere that this interpretation is not convincing,[5] and in support of this judgement it is appropriate to cite the recent publication, *Hethitische Kultmusik. Eine Untersuchung der Instrumental - und Vokalmusik anhand hethitischer Ritualtexte und von archäologischen Zeugnissen*,[6] in which Monika Schuol discusses the Hittite textual evidence for music used in ritual, with consideration of the probable meanings of words for musical instruments. She also includes a survey of relevant archaeological representations of musical instruments.

In her drawing of the sculptured relief in question, Schuol shows that there is a distinct space between the uncertain shape and the lips of the central figure who holds it, and also that there is a space between the uncertain shape and lute of the man to the left, which is shown with two strands hanging down from the end of the neck.[7] She interprets the central figure as a man bringing a gift (*Gabenbringer*), or possibly a juggler (*Gauckler*) with a trained monkey.[8] This view is supported by the details of the figure to the right, which is shown proceeding to the left and holding something to his lips. As already mentioned, the object he is holding has been interpreted by some as a wind instrument, but the outer end has an inward curving form like the pommel of a dagger and not a bell - or trumpet-shape.[9] That this is indeed likely to be a dagger and not a musical instrument has been argued by A. Ünal, who cites Hittite texts describing Hattic (pre-Indo-European-Hittite)[10] rituals which can be related reasonably to the sculptured scenes at Alaca Höyük.[11] In support of this he suggests that these sculptures, which are not typically Hittite in style,[12] are probably themselves Hattic. The texts show that music, dance, games and acrobatics were involved in the rituals, and among persons taking part was a 'dagger-man' (written with the cuneiform Sumerograms LÚ.GÍR, literally 'man.dagger' (Hittite reading unknown)), who might have been a sword-swallower, but more likely one who would hold a dagger between his teeth and throw it by flipping his head forwards, something known in modern Turkey,[13] possibly preserving an ancient tradition. This general interpretation of the scenes was already recognised partially by E. Akurgal in 1961,[14] and fully by J.G. Macqueen in 1975[15] and K. Bittel in 1976.[16]

Such an analysis is consistent with the evidence of the words for musical instruments in the Hittite texts.

In her discussion, Schuol concludes that two of these can be interpreted as wind instruments, neither of them, however, matching either of the sculptured images. One, Hittite *šăwātara-* (with variant spellings), is sometimes written with the Sumerogram SI, which shows that it was basically an '(animal's) horn'.[17] Such an instrument would have had a widening towards the outer end and probably a curving shaft, quite unlike the incurving detail and the straight shaft on the right hand sculptured image. The other word for a Hittite wind instrument, written with the Sumerograms GI.GÍD, literally 'reed/tube.long' (Hittite reading unknown), is even less relevant. It may be matched with representations of musicians playing (usually) double-pipes, sometimes with a band round the back of the neck to hold them in place,[18] again the wrong shape. Moreover, representations of these two types of wind instrument show them sloping downwards from the players' lips, while in the Alaca image the object is held upwards.

The left hand figure is clearly playing a lute, and indeed Schuol concludes that among the other Hittite words for instruments GIŠ *ḫuḫupal* (where GIŠ is the determinative for a wooden object) probably had the meaning 'lute',[19] an instrument well represented in other Hittite depictions.[20] The Alaca sculpture shows the lute with two strands hanging down from the end, probably tie-offs of the bands holding the strings against the neck.[21]

Returning to the central figure it may be noted that among the other Hittite words identified by Schuol as names of musical instruments, there is nothing likely to have meant anything like 'bagpipe'.

Apart from these considerations, the earliest convincing representations of bagpipes, which date from the Hellenistic-Roman period, already show that the bag was held, not to the lips but, under the arm, of the player, so that he could squeeze the air out through the musical pipe(s).[22] This point is also clear from the statement of Dio Cocceiānus, sometimes known as Dio Chrysostom (c. 40-c. 111+ A.D.),[23] that an individual (probably Nero) played an *aulos* (*aulein* [infinitive of *auleō*, 'play an *aulos*']) with his mouth *(stomati)* and also by means of a leather bag *(askon)* put under *(hupoballonta)* the armpit *(maskhalais)*,[24] together with the well known reference by Suetonius (c. 69-c. 122+ A.D.) to Nero playing an *utricularius*.[25] In contrast to the statement of Dio Cocceiānus, the alleged bagpiper in the Alaca Hüyük sculpture merely holds the object in front of his face.

Old Testament

The alleged Old Testament evidence consists of the word *sûmpōněyâ*, which occurs in the Aramaic section of the Biblical book of Daniel (3:5,10,15) where it is listed as the name of the last of six instruments in the 'orchestra' of Nebuchadnezzar.[26]

This raises a question as to why at any point it should have been thought appropriate to translate this as 'bagpipe'.

In the field of Old Testament studies, this may go back to the definition given in the mid-nineteenth century by the great German Hebraist Wilhelm Gesenius (1786-1842), in his *Thesaurus*, where, taking account of Classical and Rabbinic sources, he has '*tibia duplex et utricularis* (Sackpfeife, Dudelsack)' as the main definition.[27] This definition is not supported, however, by the evidence of the important Rabbinic source, the Mishna,[28] which mentions the word *sûmpōněyâ* in the *Seder Tohoroth* (Purities), *Tractate Kelim* (Utensils) 11:6, where it is named together with the *ḥālīl* (in Biblical times probably 'double-pipe'[29]), and with other utensils (spindle, distaff, rod), as susceptible to uncleanness if made of metal *(mattekeh)*, but not susceptible if only plated or overlaid *(měṣûpîn)*.[30] In other words the *sûmpōněyâ* could be either of metal, or of some material, perhaps wood, which was plated or overlaid, characteristics which in either case would be appropriate to a pipe or pipes, but not a bagpipe. The *sûmpōněyâ* is further defined in this passage as having a 'receptacle' *(qibbûl)* for 'wings, wing-feathers' *(kěnāpayim)*, the latter association being taken by some to indicate the meaning 'bagpipes'.[31] It is not clear, however, how 'wings', or other possible senses of *kānāp*, 'border; cover; hands, arms; curved attachments, handles',[32] would be part of a bagpipe. Danby has 'double-pipe' for *sûmpōněyâ* at this reference in his standard translation of the Mishna, and he speculates that *qibbūl kěnāpayim* might refer to 'a cavity containing a vibrating tongue or reed',[33] a reasonable suggestion. There is, moreover, a more plausible reference to bagpipes in the Mishna (*Kelim* 20:2), *ḥēmet ḥalîlîn*, literally 'leather-bag pipes' (assuming *ḥālīl* = 'pipe' or 'double-pipe'), an identification adopted by Danby.[34] It is clear, therefore, that in Mishnaic Hebrew *sûmpōněyâ* did not mean 'bagpipe'.

This position is reflected in the type of translation adopted for the word in the period of the Reformation. At that time knowledge of the Mishna and other later Hebrew evidence was becoming available in the Christian community, an important contribution in this field being made by the German scholar Johannes Reuchlin (1455-1522), who had studied the Talmud and other Jewish Mediaeval sources. A considerable part of his *De Rudimentis Hebraicis* (1506) consists of a selective Hebrew dictionary,[35] in which he includes words for some musical instruments,[36] but, unfortunately for the present investigation, not *sûmpōněyâ*.

Nevertheless his views may have influenced the work of his contemporaries. Martin Luther (1483-1546) purchased a copy of his *De Rudimentis* in about 1507,[37] and made use of it for his German translation

of the Bible, which was first published in 1534, and re-issued, with revisions, to the present day. In this he has *Lauten*, 'lute', for *sûmpōněyâ*,[38] a rendering retained still in the 20th century.[39] Luther's younger contemporary William Tyndale (c.1495-1536),[40] who was influenced by his translation,[41] had not reached the book of Daniel at the time of his death,[42] but his translation work influenced later English versions,[43] notably Matthew's Bible (1537), which in spite of its title was based substantially on his work.[44] This had the rendering 'Symphonies' (Dan 3:5 and 10) and 'symphonyes' (3:15), simply a transcription of Latin *symphonia*, for this word. Some decades later the Geneva Bible (1560), which represented a firmly Protestant position,[45] had 'dulcimer' for *sûmpōněyâ*, a rendering followed by the so-called 'Bishops' Bible' (1568),[46] which aimed to provide something of a counter to it, and the Authorised (King James) Version (1611).[47] John Calvin (1509-1564), the other great continental reformer, did not produce a complete translation of the Bible, but his lectures on individual books, which were taken down by students and published as commentaries, have been influential in the Protestant world. In the passage in question (Daniel 5:3), as in Matthew's Bible, he gives the Latin transcription *symphonia*.[48] It is evident therefore that the translation 'bagpipe' for *sûmpōněyâ* does not go back to the time of the Reformation, and the rendering *symphonia* continued in the intervening period, as shown for instance in a Hebrew and Aramaic lexicon published by Johannes Buxtorf the Elder in 1615.[49]

Returning to the definition given by Gesenius, this persisted in his lexicon through many editions after his time in Germany, most significantly under the editorship of Frants Buhl who oversaw the 12th to 17th editions between 1895 and 1921, but in the last two of these (the 17th being a reprint of the 16th (1915) edition) the original definition 'Sackpfeife, Dudelsack' was replaced by the cautious 'ein musikalisches Instrument'.[50] An English descendant of Gesenius's lexicon, which was published under the editorship of F. Brown, S.R. Driver and C.A. Briggs in 1906 (and therefore took account only of the 13th (1899) German edition), had a partial reversion to the earlier sense with 'bag-pipe, or < double pipe or Pan's pipe' as the main meaning. This is set out in a somewhat misleading way, however, because in it the symbol < indicates that what follows, *i.e.,* 'double pipe or Pan's pipe', is the preferred meaning.[51] This lexicon is still widely used and remains in print, and, since the significance of the symbol < is not immediately obvious there may have been a tendency for users to take the first meaning.

The principal modern Old Testament lexicon outside the Gesenius tradition, that of W. Koehler and W. Baumgartner, published in 1953, has the same definition as Brown, Driver and Briggs, though differently expressed, with 'Doppelflöte, Sackpfeife'.[52] This definition is retained in the 3rd edition (1995),[53] while a concise volume based on it by W.L. Holladay modifies it to 'most say bagpipe, but oth[ers] say "concord, harmony"'.[54]

Some of these lexical decisions,[55] have led, presumably, to the rendering 'bagpipe' in several modern English versions of the Bible: Revised Version margin (1885), Revised Standard Version (1952),[56] Jerusalem Bible (1966),[57] Tanakh (1985)[58]; and recently, English Standard Version (2001). Other translations following the same rendering include one modern German version, the *Gute Nachricht Bibel* (1998),[59] which has 'Dudelsäcke' (= bagpipe), and in French where two twentieth century versions, the Bible de Jérusalem (1956) and the Bible de la Pléiade (1959), both have 'cornemuse' (= bagpipe).

This widespread assumption that 'bagpipe' is a reasonable rendering for *sûmpōněyâ* has been rather hard to shake off, but it is clear I think that it has no sound basis.[60]

It is thus clear that there is no evidence from Alaca Höyük for any kind of bagpipe in the second millennium B.C., that there is no good reason to translate Biblical Aramaic *sûmpōněyâ* as 'bagpipe', and that there is indeed no evidence for such an instrument before the Hellenistic-Roman period.

This conclusion is not new, Curt Sachs, for instance, gave a sensible summary of the situation in 1940 when he wrote concerning what he cites as *sûmpōněyâ* that 'It is not worth while repeating once more all the erroneous and arbitrary translations given to this word in nearly two thousand years. The most stubborn of them, 'bagpipe,' was particularly inadequate since no bagpipe existed in those times.'[61] Though nearly seventy years ago he did not think it worth while to deal with the false interpretation, its persistence has shown that refutation is still necessary.

Other Possible Interpretations of Aramaic *sûmpōněyâ*

The question therefore arises. If Aramaic *sûmpōněyâ* in the Book of Daniel was not a bagpipe, what was it?

One point relevant to discussion of the Biblical evidence is the question of the dating of the book of Daniel. There has long been disagreement about this.[62] The book purports to relate to the 6th-5th century B.C., but many scholars argue that it is largely a composition of the 2nd century B.C.[63] Some of those, however, who argue for the later date would acknowledge that the first six chapters contain a basis of historical fact.

The main part of those chapters (2:4-6:28 [also 7:1-28]), including the passage in question, is in a form of Aramaic which has much in common with the Official Aramaic found in documents, mainly from Egypt, of the Achaemenian period. Among the specific arguments sometimes taken to indicate late date, and cited for instance by Galpin, is the presence in Daniel of Persian loanwords such as 'satrap' (*'ăḥašdarpān*). Galpin suggested that this points to a date in the 2nd century B.C.,[64] but this will not stand in view of the use of this word already in the 5th century B.C. in Old Persian (*ḥšaçapāvan*)[65] and as a loanword in Babylonian (*aḥšadrapannu*);[66] and in the 4th century B.C. in an Aramaic inscription from Xanthos in Asia Minor (*ḥštrpn*).[67] This is only one small point, but there are a number of other Persian words attested in Aramaic in this period.[68] A further argument for late date is the probability that the words for three of the instruments in the present passage -- *qaytĕrōs* [lyre], *pĕsantērîn* [lyre] and *sûmpōnĕyâ* [--] -- are loans from Greek.[69] This is not in itself conclusive, however, because there is clear evidence of Greek influence in the Near East already in the 6th century B.C.[70] The late J.C. Greenfield characterised the Aramaic of Daniel as Standard Literary Aramaic with some later scribal and editorial updating,[71] and in this context I will assume as a working possibility that the account of musical instruments in chapter 3 could go back to a 5th or even 6th century time.[72]

Another, perhaps marginal, point to consider in examining this list of musical instruments is the meaning of the phrase with which it concludes. This runs *wĕkōl zĕnê zĕmārā*, usually translated 'and all kinds of music', literally 'and all' (*wĕkōl*) 'kinds of' (*zĕnê*) 'the music' (*zĕmārā* [-*ā*' being the definite article]). A more considered definition of Aramaic *zĕmār* is suggested, however, by its usage in other contexts. In Ezra 7:24, another Aramaic passage, the related form *zammār* occurs in a list of Temple personnel: 'priests', 'Levites', '*zammārs*', 'gate-keepers', 'temple-slaves' and 'servants of the House of God', and it is clear from other such lists that singers and not instrumentalists were a regular part of the Temple personnel,[73] so Aramaic *zammār* here is likely to have had the meaning 'singer'. This sense is also clear in Biblical Hebrew.[74] The verb *zāmar* occurs frequently in parallelism with the verbs *šîr* [root *šyr*], 'to sing', *yādāh* 'to praise', and *hillēl [hll* in the intensive stem], 'to praise', and others, frequently in the Psalms, with similar ranges of meaning.[75] An early example of this is found in the so-called 'Song of Deborah' (Judges 5:2-30), generally considered to date from the late second millennium B.C.,[76] where, near the beginning of the Song (5:3), the verb *zāmar* (*'ăzammēr*, 'I will sing') occurs in parallelism with *šîr* (*'āšîrâ* 'I will sing').[77]

Zāmar is sometimes used of singing accompanied by musical instruments, as in Psalm 71:22, where it occurs in parallelism with *yādāh* 'to praise', in the phrases 'I will praise (*yādāh [*'ôdĕkā]*) you with (*bĕ*-) an instrument-of-a-harp (*kĕlî-nebel)*' and 'I will sing (*zāmar [*'ăzammĕrâ]*) to you with (*bĕ*-) a lyre (*kinnôr)*', but it is clear that in this context the verbs indicate singing accompanied by, rather than the playing of, the harp and lyre. The root also occurs in the noun form *zimrâ* in Isaiah 51:3 in the phrase, 'thanksgiving and the sound of singing', *tôdâ wĕqôl zimrâ*, where *tôdâ*, 'thanksgiving', implies the voice rather than an instrument, and *qôl*, though it is sometimes applied to the sound of an instrument (*e.g.*, Job 21:12), refers more often to the voice (*e.g.*, Joshua 10:14; Deuteronomy 1:34; Psalm 3:5; Genesis 3:8 [the voice of God]), and frequently in the form *mizmôr*, usually translated 'Psalm', in headings in the Psalter. Another indication of this meaning is found in the Akkadian noun *zamāru*, 'song', and verb *zamāru*, 'to sing',[78] as used, for instance, in an early second millennium text in the passage *zamar* ᵈ*bēlet-ilī a-za-ma-ar*, 'I will sing a song (in praise) of (the goddess) *Bēlet-ilī*',[79] as well as the forms *zammāru* and *zammeru*, both with the meaning 'singer'.[80] It is probable, therefore, that the passage in Daniel 3 concludes with the phrase 'and all kinds of the singing'. In both Greek texts of the Old Testament, that of Theodotion and the Septuagint, *zĕmār* is rendered by *mousikōn* at each of the four verses, and elsewhere in the Septuagint *mousikos* occurs only as the translation of *zĕmār* and *šîr*,[81] again pointing to 'singing', while in Classical Greek *mousikē* had the basic meaning 'any art over which the Muses presided, especially poetry sung to music',[82] a sense which would not go against this conclusion. In other words, the list of instruments probably concludes with the phrase 'and all kinds of singing', and not 'all kinds of music(al instruments)'. There is evidence that playing a lyre was often accompanied by singing, a likelihood which may bear on this interpretation of *zĕmār*.

With these points in mind, possible alternative renderings of *sûmpōnĕyā* may be reviewed. These can be grouped under the following headings.

1. Generalising renderings which assume no specific instrument to be meant.

These meanings depend on the assumption that *sûmpōnĕyā* was a loanword from Greek *sumphōnia*,[83] which can be analysed as 'together+sound'.[84] They include 'singing' (Authorised Version margin), 'music' (New English Bible), 'full consort' (Galpin and Revised English Bible), 'in symphony' (New King James Version), 'symphony' (Montgomery),[85] 'concord' (Farmer),[86] and 'ensemble' (Goldingay).[87] These renderings are in the same category as that found in the Latin Vulgate in the late 4th century A.D., where the word appears in Daniel 3 in the straight

transliteration *symphonia*. In Classical Latin this form is attested only in the meanings 'a harmony of sounds; a group of singers or musicians',[88] a sense presumably assumed by Jerome (c. 347-420 A.D.) in making the translation. In mediaeval Latin only the derived forms *symphoniacus*, 'musician' and *symphoniare*, 'to make music'are found.[89]

2. Instruments which involve combined sounds.

These, like those listed under heading 1 above, assume the analysis 'together+sound'. The rendering 'bagpipes', which can be ruled out, would fall in this category, but others include such translations as 'dulcimer' (Geneva Bible, Authorised Version, Revised Version), and 'pipes' (New International Version),[90] or, on this line of reasoning, more appropriate would probably be 'double-pipe' of the kind depicted in the monuments, a sense favoured by Vogt,[91] as well as by the English version of the Koehler-Baumgartner Lexicon as the first sense, and by the Brown-Driver-Briggs Lexicon as the preferred sense. Against this, however, is the fact that the *mašrôqî*, another of the instruments listed in the passage in question, was already possibly some kind of wind instrument. This interpretation is based on the assumption that *mašrôqî* is cognate with Hebrew *šāraq*, 'to hiss, whistle',[92] suggesting that it was a single or double-pipe. In that case, a second similar wind instrument (*sûmpōněyā*) would be less likely in a six-piece musical assemblage. Another possible factor, suggested by M. Ellenbogen, is that the sequence of instruments in the passage, namely: two wind instruments (*qeren* [horn] and *mašrôqî* [pipe]), then three stringed instruments (*qaytěrōs* [lyre], *śabk* [harp] and *pěsantērîn* [lyre][93]) would make return to wind with *sûmpōněyā* at the sixth unlikely,[94] though this may be assuming a more systematic sequence than is likely in ancient times.

Concerning the 'double-pipe' suggestion, the existence of such instruments is already attested by other words which have this probable meaning in Babylonian (*ebbūbu/embūbu* and later *malīlu* (Sumerian gi.gíd, 'long cane')),[95] Hebrew (*ḥālîl*), and Greek (*aulos*, 'tube, duct'), and though each of these refers basically to a single-, not a double-, pipe, the etymology in no case pointing to an element 'double', the regular representation of double-pipes in ancient Near Eastern and Greek monuments shows that they were usually   played in this way.[96] This might argue against the adoption of another similar instrument with its foreign name.

It might appear that the plausible interpretation of *sûmpōněyā* as 'doublepipe' in the Mishna would argue in favour of this rendering, but apart from the above considerations, if a 5th century date is assumed for the passage in Daniel, there is a lapse of time and culture between the

two. This is, of course, a matter for debate.

3. Drum or tambour.

This third possibility follows a proposal made in 1965 by R. Joyce that the Aramaic word *sûmpōněyā* could reflect, not an original Greek *sumphōnia*, but *tumpanon*, 'tambour, drum'.[97] Expanding on his suggestion, it can be noted that the sound change $t > s$ (assibilation) is attested in certain environments in Greek, often before i and sometimes before u.[98] This seems to have taken place at different times in different dialects, but in each case it is clear that the direction of change was $t > s$ rather than vice versa. There was a tendency to this change before the vowel i already in Mycenaean Greek,[99] and it is found subsequently, for instance, in the second person singular masculine personal pronoun, 'thou' which occurs as *tu* and *tunē* in West (including Doric) Greek, and as *su* and *tunē* in Homeric Greek, but as *su* in most other dialects.[100] Another possible instance of this sound change is found as between Greek *turannos*, and Luwian *tarwana*,[101] on one hand and Philistine (recorded in Hebrew) *seren*,[102] on the other, all with a basic meaning 'ruler'. The chronological relationships of these instances are not clear, and the absolute chronology of the Greek dialects is uncertain,[103] but if these occurrences are seen as isolated islands of evidence from language groups which were spoken over long periods, this need not be significant. *Turannos* is regarded as a loan word in Greek, perhaps from an Anatolian-Aegean linguistic substratum,[104] *tarwana* is found in the Anatolian branch of Indo-European, and *seren*, as indicated by other Philistine loanwords in Biblical Hebrew,[105] probably also derived from the Anatolian-Aegean linguistic sphere.

Perhaps in further, though more remote, support of the view that the forerunner of *sûmpōněyā* was Greek *tumpanon* and not *sumphōnia* is a description of a *symphonia* in Latin by the early medieval scholar Isodore of Seville (560-636 A.D.) in a list of musical instruments.[106] In this he says that the instrument which is popularly known *(vulgo appellatur)* as a *symphonia* was of 'hollow wood' *(lignum cavum)* with 'stretched skins' *(pelle extenta)* 'from one and the other end' *(ex utraque parte)* which 'musicians' *(musici)* 'struck' *(feriunt)* 'here and there' *(hinc et inde), i.e.,* at each end, with 'small rods' *(virgulis)*, or in other words a tambour struck by drumsticks. Among the other instruments in his list, he includes a *tympanum*, indicating that he saw the *symphonia* as different from a drum and more as a tambour. This is, of course only one isolated piece of evidence, and several centuries later in date, but Isodore was highly regarded as an authority at the time.[107]

In recent years the translation of *sûmpōněyā* as 'drum' has been adopted in the *Holy Bible. New Revised*

Standard Version (1989), as well as in the English translation of surviving parts of the Old Testament from Qumran, *The Dead Sea Scrolls Bible* (1999).[108]

In the context of this suggestion it is appropriate to examine some possibly related forms: (a) Semitic *tōp*, 'tambour'; (b) Greek *tumpanon*, 'drum'; (c) Latin *tympanum*, 'drum, tambour'; (d) Akkadian *timbuttum*, 'drum' or 'harp'(?).

(a) West Semitic *tp*, 'tambour'.

The principal word for 'drum' or more properly 'frame drum' or 'tambour' in Biblical Hebrew is *tōp*. This occurs mainly in pre-Exilic (earlier than 6th century B.C.) Biblical books.[109] The meaning 'drum' or 'tambour' is supported by the usage of the related Hebrew verb *tāpap*, 'beat', which is found for instance in Nahum 2:7 (Heb. 2:8) where it refers to women beating their breasts.

The noun *tp* is already attested in Syria-Palestine in the second millennium B.C. in an Ugaritic text (14th century B.C.) where it occurs in a sequence of musical instruments, *knr* (lyre) *ṯlb* (pipe) *tp* (tambour) and *mṣltm* (cymbals).[110] It also appears in a very damaged Ugaritic fragment, possibly an elegy,[111] in which, though the beginnings of the lines are missing, there is repetition of *w rm ṯph*, 'and high his tambour' in lines 1 and 5, and repetition of *w rm ṯlbm*, 'and high the pipes' in lines 3 and 8, (restored).[112] In this, the association with *ṯlb* confirms its interpretation as a musical instrument.

There is a possible occurrence of the verb *(tpp)* in an 8th century B.C. Aramaic inscription from Sefire in Syria in the phrase 'strike it with a sword' *(tpwh bḥrb)*.[113] The reading *tpwh* has been questioned as a scribal error for *tkwh*, which could have had the same meaning, but the *p* in *tpwh* is clear, so this is not convincing.[114] Another instance of the use of this verb in the probable sense 'to drum' is found in a Phoenician graffito of about the 5th-3rd century B.C. on the wall of the Temple of Sethos at Abydos in Egypt. This reads 'I am Psr son of Baalyaton the drummer', in which the word 'drummer' *(mtpp)* is reasonably interpreted as a participial form of the verb.[115] This implies the use of the verb in a musical sense, internationally so to speak, at that time. In addition to this textual evidence, tambours are depicted in Mesopotamian sources from the third millennium B.C. onwards,[116] and also in reliefs of the 9th-8th centuries B.C. from North Syria and southeast Asia Minor,[117] as well as in terra-cottas from Palestine.[118]

(b) Greek *tumpanon*, 'tambour'.

Greek *tumpanon* occurs fifteen times in the Septuagint, in each case as the translation of Hebrew *tōp*, 'tambour',[119] showing that in the Hellenistic period the two words were seen as having the same meaning.[120] Greek *tumpanon*, better 'tambour' than 'drum',[121] was a type

which probably originated in the Near East. The word is attested in Herodotus (5th century B.C.), where there is reference to the use of a *tumpanon* in celebration of the feast of the Mother of the Gods *(Mētri tōn theōn)*, witnessed by a Scythian at Cyzichus in northwest Asia Minor (Histories 4:76). The Mother of the Gods is usually identified with the goddess *Kubēbē*, and this connection of *Kubēbē* with the *tumpanon* is also implied by a speech given to Dionysus (Bacchus) by Euripedes in his *Bacchae*, in other words that the *tumpanon* was invented by Bacchus and Rhea,[122] Rhea being a Greek goddess often identified with *Kubēbē*. The word, in the spelling *tupanon*, is also mentioned in the 14th Homeric Hymn, but this is a composition of uncertain date, though possibly as early as the 6th century B.C.[123] Apart from this, there is no evidence, written or representational, for Greek *tumpanon* before the 5th century B.C. The Greek word can be derived quite plausibly, however, from the Greek root *tup-*, known in the verb form *tuptō*, 'beat',[124] found already in Homeric Greek[125] (perhaps c. 8th century B.C.), and with cognates in Sanskrit and early Slavonic,[126] suggesting a general Indo-European origin and therefore probable use of the verb in early Greek. It is possible that the noun might have been derived from it before its own attestation in the sources, but this is no more than speculation. It has been suggested, moreover, that most of the musical instruments of ancient Greece were part of a general musical culture of the Near East, Asia Minor and the Aegean, and did not originate in Greece itself.[127]

The question arises, If there was a tambour-type instrument attested in the Near East already in the second millennium B.C., would an Indo-European version of a similar instrument have been brought into the area? One possible line of speculation on this point might start from the observation, already seen in Herodotus and Euripedes, that in the Greek sources the word *tumpanon* occurs particularly in texts referring to cult practices involved in the worship of Rhea *(Kubelē)* and Bacchus (another name, probably Lydian, of Dionysus) both originating in Asia Minor, *Kubelē* being known to the Greeks and Romans as the great mother goddess of the Phrygians.

The Greek name *Kubelē* is sometimes written *Kubēbē*, and there is a good case for identifying her with the Anatolian Great Mother *Kubaba*, originally the principal goddess of Carchemish in north Syria, who had been brought into the Hittite pantheon by the 13th century B.C.,[128] and adopted by the Phrygians in the late second or early first millennium B.C.[129]

That Kubaba was associated with music in the time of the Phrygians is demonstrated by a statue of the 6th century B.C. from Boğazköy which shows her seated

between two small standing figures playing doublepipes and a lyre.[130] To what extent any details of the cult seen in later Greek or Roman culture originated in Asia Minor, and might therefore illustrate a possible channel for a special kind of *tumpanon* to come to Mesopotamia, can be no more than speculation. Laroche has pointed out that in the relief sculptures from Carchemish and related sites the only objects clearly associated with *Kubaba* are a mirror and a pomegranate,[131] but tambours (as well as lyres, lutes, double-pipes, horns and drums) are clearly depicted in reliefs of the 9th-8th centuries B.C. from Carchemish as well as Zinjirli (in north Syria) and Karatepe (in southeast Asia Minor),[132] though there is not specific evidence to show that at Carchemish they were associated with *Kubaba*. This therefore remains only one theoretical possibility.

(c) Latin *tympanum*, 'drum, tambour'. It is worth mentioning Latin *tympanum*, the counterpart of Greek *tumpanon*, because it is a word found in the descriptions of the revels related to Cybele, the Roman form of *Kubelē*, supporting the connection of *Kubēbē* with the instrument. She was introduced officially with accompanying acolytes to a special temple on the Palatine Hill in Rome in 204 B.C.,[133] and Latin sources give details of the practice of the cult,[134] which included the use of the tambour (*tympanum*).[135] A typical example of the instrument is illustrated in a sculptured plaque, probably a tomb relief, of the 2nd century A.D., found near Rome in 1736, which shows a priest of the cult next to a tambour (as well as cymbals and straight and curved pipes).[136]

It may be noted that the word *tympanum* occurs in the Latin Vulgate as the rendering of Old Testament Hebrew *tōp*.[137] This was the translation adopted by Jerome (c. 347-420 A.D.), who worked from the Hebrew text, and not merely from the Septuagint. He may have understood the word to mean 'drum' rather than 'tambour', in the way implied about a century and a half later when Isodore of Seville included the *tympanum* and the *symphonia* as two separate entries in his list instruments, with his description of the latter pointing to something very much like a tambour.[138] It is worth pointing out that the Latin word for a bagpipe *(utricularius)* was quite different, in Imperial times at least, as indicated by the passages in Suetonius and Dio Cocceiānus mentioned above.[139]

d) Akkadian *timbuttum*, 'drum' or 'harp'(?).

This word, which is attested in various spellings,[140] may have no connection with *tumpanon*, but the superficial similarity suggests that it is worth investigating. The evidence for its meaning is equivocal, and though the Chicago Assyrian Dictionary favours its interpretation as a type of harp,[141] the meaning 'drum' is proposed by others.[142] The identification of this instrument is based on equivalences found in cuneiform lexical lists (giving Sumerian and Akkadian equivalents), namely

giš.balaĝ.di = *tim-bu-ut-tum*,[143] and kuš.balaĝ.di = *mašak* = *tim-bu-tu*,[144] in which Sumerian balaĝ[145] (= Akkadian *balaggu*) is defined in one case by the determinative giš, 'wood' and in the other by kuš (= *mašku*), 'hide, leather'. The materials 'wood' and 'hide' would certainly be appropriate to a drum or tambour, but the sounding boxes of stringed instruments were sometimes covered with leather, as for instance in the case of an Egyptian lyre in the British Museum (BM.E. 38170), dated to the New Kingdom period (c. 1600- c. 1100 B.C.), which has skin or hide wrapped round the sound-box,[146] so this factor would not necessarily settle the question.

Different meanings have been proposed for Sumerian balaĝ: (a) some kind of 'harp',[147] or (b) 'drum, tambour' or something of the kind.[148] The evidence is not decisive. The Chicago Assyrian Dictionary is con-committal with '(a musical instrument)',[149] and Kilmer suggests that in some contexts the sound box of the instrument could have been used as a drummable resonator while serving at the same time as part of a stringed instrument.[150] The word *timbuttum* is not new in the Akkadian vocabulary, being attested possibly already in the Old Akkadian period (third millennium B.C.), but mainly from the second millennium onwards.[151]

This is rather slippery material, and its inclusion here may serve only to show that it does not contribute to the discussion, unless Aramaic *sûmpōněyâ* in the Old Testament might represent a miscopied native Akkadian spelling such as *timbūtu* and not a Greek loanword. In that case, the instrument might have been some kind of drummable harp, but this again is straying well into the sphere of speculation.

Leaving aside such a possible Akkadian form, and bearing in mind (a) that there are representations of tambours in Mesopotamian sources from the third millennium B.C. onwards,[152] and in Syrian and Palestinian sources from the eighth-seventh centuries B.C. onwards;[153] and (b) that there is attestation of probable tambours in Ugaritic texts of the 14th century B.C., and in Greek texts by the 5th century B.C.; together with the theoretical possibility of the use of tambours in the Kubaba/Kubēbē cult in Asia Minor earlier in the first millennium B.C., it might be possible to postulate a foreign type of tambour in Babylonia in the 6th century B.C.

Conclusion

With the above considerations in mind, I would suggest rendering the passage in Daniel 3, 'horn, pipe, lyre, harp, lyre, tambour, and all kinds of singing'.

Notes

1 Scholes, P.A. (1938-Oxford) *The Oxford Companion to Music.* (10th ed. rev. by J.O. Ward): 65. These assertions are implicitly rejected by Cocks, W.A.; Baines, A.C. and Cannon, R.D. (2001-London) in *The New Grove Dictionary of Music and Musicians* 2: 471 ('on re-examination, such claims [of early bagpipes] may all be discounted').

2 Garstang, J. (2001-London) in *The Land of the Hittites. An Account of Recent Explorations and Discoveries in Asia Minor, with Descriptions of the Hittite Monuments:* pl. LXXIII lower: 260-1, with a plan of the Sphinx Gate of which it was part: 247 (the two slabs being f and e [numbered incorrectly 'fourth stone' [d] and e in the text]), bibliography of earlier references: 397; and *The Hittite Empire (*1929-London) pl. XXX lower [the same photograph]: 137, plan of the Sphinx Gate: 127 (the two slabs being f and e [again numbered incorrectly 'fourth stone' [d] and e in the text]), earlier bibliography: 339; drawing of these slabs and probable locations of others adjacent to them in Mellink, M.J. (1970) 'Observations on the Sculptures of Alaca Hüyük', *Anadolu (Anatolia)* 14: 15-27, fig. 2; and photographs of all slabs at the gate in Bossert, H.Th. (1942-Berlin) Altanatolien: 53-4 with illustrations nos 502-525 (the slab in question being in no. 506 and together with the one to its right in no. 508); the lute illustrated by Stauder, W. (1970-Leiden) in Hickmann, H. and Stauder, W., *Orientalische Musik* [Handbuch der Orientalistik, I, Erganzungsband]. fig. 2g: 190) with: 196 (wrongly attributing it to 'Alischar Hüyük'). The slabs in question are now in the Museum of Anatolian Civilizations (formerly the Hittite Museum), Ankara.

3 'Notes on a Journey through Asia Minor', *Liverpool Annals of Archaeology and Anthropology* 1 (1908): 1-12, specifically 2, 3, pls I (map: the site marked as Uyuk) II (general view showing part of the right hand figure only).

4 Garstang, *The Land of the Hittites*: 260-261; extracts repeated word for word in Hittite Empire: 137. He cites the supposed reference to a dog-skin bagpipe in Aristophanes, Acharnians (on which see below no. 60) in support of this interpretation (Land: 261 n.1 and Empire: 137 no. 3).

5 Mitchell, T. 1992 PEQ 124: 135. This was already recognised by Sachs (*History of Musical Instruments:* 141), who included a photograph of the lute player and the animal held by the central figure (without the man holding it) with the caption 'Hettite lutanist (no bagpipe), from Eyuk' (*History of Musical Instruments*, pl. IV. F).

6 [Deutsches Archäologisches Institut (2004-Rahden). Orient-Archäologie 14].

7 Schuol, *Hethitische Kultmusik*, pl. 9 no. 29. This is also clear in the photograph in Vieyra, M. (1955-London) Hittite Art 2300-750 B.C. pl. 31. In the photograph published by Garstang (*Land*, pl. LXXIII = *Empire*, pl. XXX) the space between the shape and the man's face cannot be seen, but the shape looks very much like an animal.

8 Schuol, *Hethitische Kultmusik*: 66-7, §3.2.1.29.

9 Schuol, *Hethitische Kultmusik:* pl. 10 no. 30 with discussion: 67-68, §3.2.1.30; the pommel-like form is clear in Akurgal, E. and Hirmer, M. *Die Kunst der Hethiter.* Munich: Pl. 93 upper; and also in Vieyra, *Hittite Art:* pl. 30.

10 The 'Hattians' being among the pre-Hittite inhabitants of the country who continued as a significant element of the population in Hittite times.

11 Ünal, A. (1994) 'The Textual Illustration of the 'Jester Scene' on the Sculptures of Alaca Hüyük', *Anatolian Studies* 44: 207-20.

12 Frankfort, H., characterises them as 'poorly cut' and lacking 'the corporeality which the thorough modelling imparted to the figures at Boğazköy and Yazilikaya' (the Hittite capital and the principal shrine nearby). 'At Alaja Hüyük the figures are merely

outlined and stand quite flat above the background, which has been chiselled down. The details are rendered by engraved lines, not by modelling; *The Art and Architecture of the Ancient Orient* (1st pb. ed., Harmondsworth (1970): 231-2.

13 Ünal (1994) *Anatolian Studies* 44: 215-6.

14 Akurgal, E. and Hirmer, M. (1961-Munich) *Die Kunst der Hethiter*. pl. 93 upper 'Jongleur und Akrobaten', the left hand slab is not included.

15 Macqueen, J.G. (1975-London) *The Hittites and their Contemporaries in Asia Minor:* pl. 56 'a musician and a man carrying an animal (a dog or monkey?): 55 'a group of acrobats . . . the one on the left is a sword-swallower'.

16 Bittel, K. (1976-Munich) *Die Hethiter*, figs. 219 ('Lautenspieler und Gabenträger') and 218 ('Gauklerszene').

17 Schuol, *Hethitische Kultmusik*: 132-136, §4.10, with pl. 11.36 (Carchemish, 1st millennium B.C.). In Mesopotamian texts, however, the Sumerogram SI (Babylonian *qarnu*) does not occur in contexts where it refers to a musical instrument. *The Assyrian Dictionary* (1982-Chicago) [hereafter CAD] 13, Q: 134-40.

18 *E.g.,* Schuol, Hethitische Kultmusik: 129-31, §4.9, pls 11.35; 13.41.1 and 2; 14.44, 15.43 and 17.50.1.

19 Schuol, *Hethitische Kultmusik*: 108-12, §4.3; already concluded by Hoffner, H.A. (1967) in *Revue Hittite et Asianique* 2: 60 ('lute (?); instr. that is struck'); and Gurney, O.R. (1977-Oxford) *Some Aspects of Hittite Religion* [Schweich Lectures 1976]: 35.

20 *E.g.,* Schuol, *Hethitische Kultmusik*: pls. 3.9 and 9.4; 4.10 and 11; 6.23; 11.35; 12.37 and 38.

21 These hanging strands can be seen in other examples, *e.g.,* Schuol, *Hethitische Kultmusik:* pls. 4.11; 11.35; 12.37 and 38. They are analogous to the tassels shown on Egyptian lutes (*e.g.,* Sachs, *History of Musical Instruments*: fig. 33: 102). Sachs shows these hanging strands on the Alaca lute in his pl. IV F, and rightly points out that they are part of the lute, and not pipes descending from the animal (the alleged bagpipe) carried by the central figure.

22 The clearest early example is a terracotta figure from Alexandria now in the Staatliche Museum, Berlin, dated by Hickman, H. (1961-Leipzig) to c. 100 B.C.: see Hickman, *Ägypten* [Musikgeschichte in Bildern, 2, Musik des Altertums, 1]: 94-5 fig. 58 (with discussion), 169; Sachs, *History of Musical Instruments*, pl. VIIIc and p. 143 (designating it 'ancestor of the organ'); Baines, A., *Bagpipes* (1995-Oxford) [Pitt Rivers Occasional Papers on Technology, 9] (3rd ed.: 62 fig. 35 (discussion: 62-3); illustrated also in F. Collinson (1969) 'Syrinx and Bagpipe: a Romano-British Representation?' *Antiquity* 43: 305-8, pls. XLIV-XLV, specifically: 305-306, pl.XLIV.c; and mentioned in West, M.L. (1992-Oxford) *Ancient Greek Music*: 108 and no. 118. This shows a seated man playing a panpipe but holding a bag under his arm with a pipe attached into which a small second figure at his feet is blowing, so it does not represent a typical bagpipe as later known, but it does demonstrate the underarm position of the bag. Another proposed early representation of a bagpipe occurs on a carved seal-stone in a private collection, dated by Boardman on stylistic grounds to the Hellenistic period (Boardman, J. (1968-London) *Engraved Gems: The Ionides Collection*. no. 16 (Ionides no. 71): 21-22, 93); reproduced also in *Antiquity* 43 (1969), pl. XLV (b), with p. 307): this shows a convincing bagpipe (with three pipes) hanging in a tree above a seated naked man, but, as Boardman notes: 93, similar seals were produced in the eighteenth century, such as in Dalton, O.M. (1915-London) *Catalogue of the Engraved Gems of the post-Classical Period in the British Museum*: 102 no. 706, pl. XXV (without bagpipes) 'Silenus sitting naked on a rock; 18th century A.D.', Dalton also gives a useful survey of the craftsmen who produced these gems in his Introduction); and another in Lippold, G. (1922) *Gemmen und Kameen des Altertums und der Neuzeit*. Stuttgart: pl. CVIII.4, with: 183 (classified under the

heading 'Neuere glyptik', and discussion of Renaissance and later seal cutting techniques: xi-xii). At the 2008 British Museum ICONEA Symposium, Dr. Susanna Rühling suggested that the bagpipe seal published by Boardman should be dated, by implication with these examples, in the post-Classical rather than the Hellenistic period, in which case its value as evidence is at least debatable.

23 On whom see Bürchner in Pauly, A., Wissowa, and Kroll, W., eds (1903-Stuttgart) *Real-Encyclopädie der klassischen Altertumswissenschaft*, IX: coll. 848-77, Dion no. 18; Browning, R., in Hammond, N.G.L., and Scullard, H.H. eds (1970-Oxford) *The Oxford Classical Dictionary*, 2nd ed.: 345; and briefly Howatson, M.C. (1989-Oxford) *The Oxford Companion to Classical Literature*, 2nd ed.: 191.

24 Discourse 71:9: Cohoon, J.W., and Crosby, H.L., (1951) *Dio Chrysostom*, V [Loeb, 385]: 172-173; also quoted by Baines, *Bagpipe*: 60, Greek text in no. 3.

25 *De vita Caesarum*, Nero, LIV: Latin text in Ihm, M. (1907) *C. Suetoni Tranquilli. De Vita Caesarium, VIII*. Leipzig: 269. English trans. e.g., by R. Graves 1957 Suetonius. *The Twelve Caesars*. Harmondsworth: 240; (rev. and illustrated. ed., Harmondsworth, 1980): 208.

26 The 'orchestra' is listed four times in this passage: in Daniel 3:5,7,10 and 15. The word is written as *sûmpōněyâ*, in 3:5 and 15, and as *sîppōněyâ* in 3:10, but is omitted in 3:7.

27 *Thesaurus Philologicus Criticus Linguae Hebraeae et Chaldaeae Veteris Testamenti*, Part II. Leipzig, 1840: 941-942. This was an enlarged version of his *Hebräisch-deutsches Handwörterbuch über die Schriften des Alten Testaments* (Leipzig, 1810-2).

28 The Mishna consists of Rabbinic traditions collected over several centuries and probably written down by the 2nd century A.D. English translation in Danby, H. (1933) *The Mishnah*. Oxford, and the text conveniently set out with English translation etc., in Blackman, P. (1951-1957) *Mishnayoth. Printed Hebrew Text, English Translation, Introductions, Notes, etc.*, I-VII. London. Revised and enlarged ed.; New York, 1964.

29 Mitchell, T.C. 1992 *PEQ* 124: 131 (in 'The Music of the Old Testament Reconsidered': 124-43). In discussion of this and related instruments the rendering 'pipe' rather than 'flute' will be used here, because, as West, M.L. (1992-Oxford) has pointed out (*Ancient Greek Music*): 81, with a flute the sound is produced by blowing across the end or across a side aperture of a tube, whereas with a pipe the sound is produced by blowing down the tube, usually through a mouthpiece containing a vibrating reed.

30 For the meaning of *měšûpîn* in Biblical Hebrew see Koehler, L., and Baumgartner, W., *et al.* (2001-Leiden, Boston and Cologne) *The Hebrew and Aramaic Lexicon of the Old Testament*, Study Edition trans. and ed. Richardson, M.E.J. II: 1045, ph II; Steins, G., 'ṣāpâ', in Botterweck, G.J., Ringgren, H., and Fabry, H.-J., (eds) (2003-Grand Rapids and Cambridge) *Theological Dictionary of the Old Testament* [hereafter *TDOT*], XII: 429-435, specifically 434-5, §V.

31 Jastrow, M. (1926-New York) *A Dictionary of the Targumim, the Talmud Babli and Yerushalmi, and the Midrashic Literature* 2nd ed.; II: 982, though, apart from this passage, he favours 'double flute'; Krauss, S. (1912-Leipzig) also has 'Sackpfeife' for *sûmpōněyâ* in both *Talmudische Archäologie III.*: 88 §7; and *Griechische und Lateinische Lehnwörter im Talmud, II* (1899-Berlin) repr. Hildesheim, 1964): 376, though in *Talmudische Archäologie* he argues that *'ûgāb* meant 'Sackpfeife, Dudelsack' (p. 88 §6), depending at this point to some extent on Benzinger, I. (1893-Leipzig) *Hebräische Archäologie*: 276 = 3rd ed.; (1927): 249. In the Biblical period the identification of *'ûgāb* is uncertain: *PEQ* 124 (1992): 131; Koehler and Baumgartner (2001-Leiden) *Hebrew and Aramaic Lexicon* I: 795 suggest '(long) flute' but only for Job 30:31.

32 Senses listed by Jastrow, *Dictionary*, II: 982; see also W. Dommershausen, '*kānāp*' in Botterweck, Ringgren and Fabry, *TDOT*, VII (1995): 229-31, various meanings, and citing the Septuagint

renderings *pterux* and its diminutive *pterugion*, both primarily 'bird wings', but secondarily 'anything like a wing'.

33 *Kelim* 11:6: Danby, *Mishnah*: 620; Blackman, *Mishnayoth*, VI: 84, also has 'double flute' for *sûmpōněyâ* at this reference; and Danby further has it as 'double pipe' at *Kelim* 16:8 (*Mishna*: 628).

34 *Kelim*, 20:2: Danby, *The Mishnah*: 635; Blackman, *Mishnayoth*, VI: 138, also has 'bagpipes'; and Jastrow accepts the meaning 'bagpipe' in this passage (*Dictionary*, I: 480).

35 Modern Old Testament lexicons place the Aramaic vocabulary in a separate alphabetical section at the end, but at that time, and still in Gesenius's *Thesaurus*, the vocabulary, which occupies a considerable part of the volume: 32-545, was set out in a single alphabetical sequence. On Reuchlin see Lloyd Jones, *The Discovery of Hebrew in Tudor England*: 23-6; Lindsay, T.M. (1907-Edinburgh) *A History of the Reformation* (rev. ed. I: 67-72; Box, G.H. (1927-Oxford) in Bevan, E.R., and Singer, C., *The Legacy of Israel*: 319-23 (reference to Luther: 322); Green, V.H.H. (1964-London and New York) *Luther and the Reformation*: 119.

36 *E.g.*, kinnôr, 'Cithara': 248, *nēbel*, 'Lyra seu psalterium': 303, qeren, 'Cornu': 477.

37 Lloyd Jones, *Discovery of Hebrew in Tudor England*: 57-8; also Box in Bevan and Singer (eds.), Legacy of Israel: 348. Luther had contact with Reuchlin's great nephew Philipp Melanchthon (1497-1560), who changed his name from Schwartzerdt at the suggestion of Reuchlin.

38 *Die gantze Heilige Schrifft: Deudsch* (1545). I am indebted to Wolfgang and Priscilla Meyer for providing me with a photocopy of this passage.

39 *Die Bibel oder die ganze Heilige Schrift des Alten und Neuen Testaments Nach der deutschen übersetzung D. Martin Luthers, Das Alte Testament Nach dem 1912 vom Deutschen Evangelischen Kirchenausschuß genehmigten Text* (Stuttgart, n.d.).

40 *E.g*, S.L. Greenslade (1963-Cambridge) in Greenslade (ed.), *The Cambridge History of the Bible*, III: 145-146.

41 Lloyd Jones, *Discovery of Hebrew in Tudor England:* 118-119.

42 What he did complete is published in full in Daniell, Tyndale, *Old Testament, being the Pentateuch of 1530, Joshua to 2 Chronicles of 1537 and Jonah*, Translated by William Tyndale (1992-New Haven and London). See also Bobrick, B. (2001-London) *The Making of the English Bible*: 245-246; and Box in Bevan and Singer (eds), *Legacy of Israel*: 348.

43 Greenslade, *Cambridge History of the Bible*, III: 144-165.

44 Bruce, F.F. 1961 *The English Bible*. London: 64-66.

45 Lloyd Jones, *Discovery of Hebrew in Tudor England:* 127-132; Bruce, English Bible: 86-92.

46 *The Holy Byble containing the Olde Testament and the Newe. Authorised and appointed to be read in Churches. Imprinted at London by Christopher Barker Printer to the Queenes most excellent Maiestie. Anno 1585*, a printing in which there had been some revision of the 1568 edition. On this version, which was basically a revision of the Great Bible, itself the result of successive revisions of Tyndale's translation, see Bruce, *English Bible*: 92-95, and 70 (on the Great Bible).

47 The New King James Version (1982) has gone back to 'in symphony'.

48 Conveniently in *Daniel I (chapters 1-6), translated by Parker, T.H.L. John Calvin's Lectures on the Book of the Prophecies of Daniel. Taken down by the effort and industry of Jean Budé and Charles Joinviller*, Geneva, MDLXI [Calvin's Old Testament Commentaries, Volume 20] (1993-Grand Rapids and Carlisle): 118.

49 Buxtorf, J. I, 1615 *Lexikon Hebraicum et Chaldaicum complectens*. Basileae: 508, *s.v.* סמף 'Symphonia, συμφωνιά, recognising the word as a loan from Greek, 'A Graecis mutuata vox'. On Buxtorf and his son see Box in Bevan and Singer (eds), *Legacy of Israel*: 349-351.

50 Buhl, F. (1921) Wilhelm *Gesenius' Hebräisches und Aramäisches Handwörterbuch über das Alte Testament* (17th ed. Leipzig:

917, with reference to modern *samponja* and *zampogna* in Asia Minor and Italy, both with the meaning 'Sackpfeife'. Work has begun on an 18th edition of this lexicon, the first part having appeared in 1987 (Meyer, D.R., and Donner, H., (eds), (1987-Berlin, Heidelberg, etc.) *Wilhelm Gesenius Hebräisches und Aramäisches Handwörterbuch über das Alte Testament*: 1 א-ג (1987), 2 ד-י (1995), and continuing), but it will be some time before it reaches the word in question, which will be in the Aramaic section at the end, after the Hebrew alphabet is completed.

51 *A Hebrew and English Lexicon of the Old Testament* (1906-Oxford): 1104. Driver (1900-Cambridge), however, who had a major role in preparation of the Old Testament part of the Revised Version of the Bible, elsewhere favoured 'bagpipe' (*The Book of Daniel* [Cambridge Bible for Schools and Colleges]: 39). The sense 'bagpipe' is also taken, with supporting references from Polybius (c. 2nd century B.C.), by Charles, R.H. (1929-Oxford) *A Critical and Exegetical Commentary on the Book of Daniel*: 64; and more concisely his *The Book of Daniel* [Century Bible]. Edinburgh, n.d.: 31.

52 *Hebräisches und Aramäisches Lexikon zum Alten Testament* (1953-Leiden).

53 Koehler and Baumgartner with Stamm, J.J., and Hartmann, B. (1995-Leiden) *Hebräisches und Aramäisches Lexikon zum Alten Testament, V, Aramäisches Lexikon:* 1751-1752.

54 *A Concise Hebrew and Aramaic Lexicon of the Old Testament* (1971-Leiden): 414.

55 The bagpipe interpretation is also accepted *e.g.,* by Grelot, P. (1979) *Vetus Testamentum* 29: 36-38), followed by Beyer, K. (1984-Göttingen) (in the glossary in his useful volume, *Die aramäischen Texte vom Toten Meer:* 644), as well as in some general books on ancient music such as Polin, C.C.J. (1954-New York) who takes it for granted that symphonia = bagpipe on the basis of Daniel 3:10 (*Music of the Ancient Near East:* 63), though she adds that it 'may also have been a double flute', but she states subsequently without comment or justification that the 'bagpipe' was used by the Assyrians: 91, and Syrians: 101; and even Kraeling, C.H. (1957-Oxford) considers it 'possibly a bagpipe' (in Wellesz, E., and Farmer, H.G., (eds), *The New Oxford History of Music*, I: 300).

56 Though this is changed to 'drum' in the New Revised Standard Version (1989), see below.

57 Translating French *cornemuse*.

58 *Tanakh. The Holy Scriptures. The New JPS Translation According to the Traditional Hebrew Text* (Philadelphia, Jerusalem) [JPS = Jewish Publication Society].

59 *Bibel in heutigem Deutsch* (1997-Stuttgart) (Revidierte Fassung; Deutsche Bibelgesellschaft).

60 This view is reflected by a recent departure from the 'bagpipe' rendering in the English version of the Koehler-Baumgartner, *Lexikon* (ed. by Richardson, M.E.J., (2001)II: 1937-1938, which has 'double barrelled flute, sackbut' [though the latter definition, perhaps adopted on the basis of a confusion of English 'sackbut' with German 'Sackpfeife', is an unfortunate choice since there is no evidence of a sackbut (trombone) until the 15th century A.D. (See *e.g.,* Sachs, C., *The History of Musical Instruments* (1940-New York): 325-327; Remnant, M. (1978-London) *Musical Instruments of the West:* 155; according to the Oxford English Dictionary 'the word [sackbut] is not found as the name of a musical instrument earlier than the latter half of the 15thc., but presumably identical with O[ld] N[orthern] F[rench] saqueboute, explained in the 14thc. as a lance furnished with an iron hook for pulling men off their horses' (2nd ed.; ed., Simpson, J.A., and Weiner, E.S.C., (1989) XIV: 333), the in-and-out motion of the trombone perhaps evoking this image.), and it offers an even less appropriate definition than 'bagpipe')]. It is worth mentioning the opinion of Galpin, F.W. (1937-Cambridge) who gives some attention to the word sumponya in his book *The Music of the Sumerians and their Immediate Successors the Babylonians and Assyrians*. He

follows the view that much of the Book of Daniel is to be dated in 2nd century B.C., so he deals mainly with meanings attested in Roman and early Mediaeval times, concluding that *sumponya* is probably to be translated as 'full consort': 66-69. Baines, A., in his monograph on bagpipes is non-committal with his statement that 'no real agreement has been reached over the meaning of *sūmponiāh* and *sippōnyā* in the third chapter of the Aramaic text of the Book of Daniel': 61 n.2). His uncertainty may be coloured by his acceptance of the possibility that some kind of bagpipe may be referred to in a passage in *The Acharnians* (425 B.C.) of Aristophanes, where he takes the passage *auleitai para tois ostinois phuseite ton prokton kunos* to mean 'with bone pipes blow the posterior of a dog' (*Acharnians,* 862: Baines, *Bagpipes*: 58-61. This is not convincing however, and this interpretation is consistently rejected by commentators, who take *prokton kunos* in this context as the title of a vulgar song, 'Dog's Posterior' or the like, with suggested renderings of varying crudeness (Rennie, W. (1909-London)) *The Acharnians of Aristophanes with Introduction, Critical Notes and Commentary:* 218-219; Starkie, W.J.M. (1909-London) *The Acharnians of Aristophanes with Introduction, English Prose Translation, Critical Notes and Commentary*: 178-179; Olson, S. D. (2002-Oxford) *Aristophanes Acharnians, edited with Introduction and Commentary*: 288-289; as well as Henderson, J. (1998) in the Loeb edition of the text; and brief dismissal by West (*Ancient Greek Music:* 109 no. 121). It has to be admitted that some of the reasoning by the commentators in support of this conclusion begs the question by assuming that there was no bag-pipe before Hellenistic times, but perhaps more relevant is the observation that the verb *phusa*, 'blow' is never used in a complimentary way of pipe playing, supporting the view that this is a vulgar or contemptuous reference. West also shows the improbability of reference to a bagpipe in Aristophanes, *Lysistrata*, 1242-1246 (*Ancient Greek Music:* 109).

61 *The History of Musical Instruments* (1940-New York): 84; this is the conclusion also of West, *Ancient Greek Music:* 107-109; Remnant, M. (1978) *Musical Instruments of the West:* 135; and Abraham, G. (1979-London) *The Concise Oxford History of Music*. : 44, 45-46; and also of Werner, E., in Buttrick, G.A, *et al.* eds; (1962- Nashville and New York) *The Interpreter's Dictionary of the Bible* 3: 476 (but accepting the interpretation of Jerome [see below], as taken up by Galpin and Sachs, that it referred to 'the ensemble playing of all the instruments').

62 Survey of pre-1939 discussion of this question in Rosenthal, F. (1939-Leiden), *Die Aramaistische Forschung seit Th. Nöldeke's Verffentlichungen*: 65-71.

63 *E.g.,* Fohrer, *Introduction*: 477-478 (2nd century B.C.); but Dillard, R.B., and Longman, T. (1994-Grand Rapids) *An Introduction to the Old Testament:* 332 (6th century B.C.).

64 Galpin, *Music of the Sumerians:* 66.

65 Kent, R.G. (1953-New Haven) *Old Persian. Grammar. Texts. Lexicon.* 2nd ed.: 181.

66 *CAD*, 1, A.1 (1995): 195.

67 Hoftijzer, J., and Jongeling, K. (1995-Leiden) *Dictionary of the North-West Semitic Inscriptions* I: 412.

68 See *e.g.,* Greenfield, J.C., (1987-London and New York) 'Iranian Loanwords in Early Aramaic' in Yarshater, E., (ed.), *Encyclopaedia Iranica II*: 256-9; Kitchen, K.A. (1965-London) in Wiseman, D.J., *et al. Notes on Some Problems in the Book of Daniel*: 35-44; see also Widengren, G. in Wiseman, D.J., (ed.) (1973-Oxford) *Peoples of Old Testament Times*: 342-3 with 352-35 nos 106-108.

69 That *sūmpōněyā* was a loanword is emphasised by the variant Masoretic spellings *sûmpōněyā*, and *sîppōněyā*, the difference being evident also in the unvocalised forms *swmpnyh* and *sypnyh*.

70 Mitchell, T.C. (1992) *PEQ* 124: 136; and Kitchen in Wiseman, *Notes on Some Problems*, pp 44-6; Mitchell and Joyce, R., *in ibid.*: 19-27; and briefly on the general culture, Boardman, J. (1999-London) *The Greeks Overseas. Their Early Colonies and Trade.* 4th ed.: 51-52.

71 See *e.g.,* Naveh, J., and Greenfield, J.C. (1984-Cambridge) in Davies, W.D., and Finkelstein, L. (eds), *The Cambridge History of Judaism*,

I, Introduction;   the Persian Period.: 117-118; and Greenfield in Gershevitch, I., (ed.) (1985-Cambridge) *The Cambridge History of Iran, 2, The Median and Achaemenian Periods:* 707; and in Geller, M., Greenfield, J.C., and Weitzman, M.P., (eds), (1995-London) *Studia Aramaica. New Sources and New Approaches* [JSS, Supplement 4]: 5; see also Rosenthal, F. (1974-Wiesbaden) *A Grammar of Biblical Aramaic* (Fourth Printing: 5-6. (Biblical Aramaic 'largely identical with the language used in other Official Aramaic texts'); and for a vigorous statement of the case for a 6th-5th century date, Kitchen in Wiseman, *Notes on Some Problems:* 31-79, particularly 50-77 on the Aramaic; on a different aspect Ginsberg, H.L. points out that in Daniel 1-6 there is no reflection of or allusion to the situation in 2nd century Palestine (the time of Antiochus Epiphanes), which is often claimed as the context of composition (in Davies, W.D. and Finkelstein, L. (eds), (1989-Cambridge) *The Cambridge History of Judaism, 2, The Hellenistic Age:* 504-505.

72 The continuing debate about the book is referred to by Barr, J., in Davies and Finkelstein (eds), *Cambridge History of Judaism, 2, The Hellenistic Age:* 91-92.

73 See *e.g.,* de Vaux, R., (1961-London) *Ancient Israel. Its Life and Institutions:* 382-383, 391-392.

74 See useful survey of the etymology and Old Testament usage of the term, Barth, C., '*zmr*' in Botterweck, G.J., and Ringgren, H., (eds), (1980-Grand Rapids) *Theological Dictionary of the Old Testament, IV*: 91-98, where, however, he retains the translation 'musical instruments' for *zĕmār* in Daniel 3: 92, against the main sense of his article.

75 Barth, *TDOT,* IV: 94-5.

76 *e.g.,* Fohrer, *Introduction:* 209.

77 See Albright, W.F. (1922-Missoula) '*The Earliest Forms of Hebrew Verse*', *JPOS* 2: 69-86, specifically 74 (text), 81 (trans.), with 73 (on the verbs); with 'The Song of Deborah in the Light of Archaeology', 1936 *BASOR* 62: 26-31 (supporting a date in c. 12th century B.C.); also Cross, F.M., and Freedman, D.N. 1975 *Studies in Ancient Yahwistic Poetry* [SBL Dissertation 21]: 13 (text and trans.), also 4-8 (dating of this and other early poetry).

78 *CAD* 21 Z: 35-38.

79 Cited in *CAD* 21 Z: 37 §1.a.

80 *CAD* 21 Z: 39-40.

81 Hatch, E., and Redpath, H.A. (1897-Oxford) *A Concordance of the Septuagint* II: 935 (some of the occurrences are in Apocryphal books which have no Hebrew or Aramaic forerunner).

82 Liddell, H.G. (1925-1940-Oxford) and Scott, R. *A Greek-English Lexicon.* 9th ed. Revised by H.S. Jones: 1148-1149.

83 *e.g.,* Rosenthal, F. (1961-Wiesbaden) *A Grammar of Biblical Aramaic:* 59; de Lange, N. V in Christides, A.F., (ed.), *A History of Ancient Greek.* Cambridge: 805-6; Brock, S. in *ibid.*: 819; Brown, Driver and Briggs (1906) *Lexicon:* 1104, give it as 'loan-word fr. (late) Gk. συμφωνια (concerning the comment '(late)', see above). The variant spelling *sîppōnĕyā* in Daniel 3:10 is simply *sîmpōnĕyā* with assimilation of m to the following p, and assuming a vowel change *û>î*. *Sumphōnia* is in fact the form by which *sîmpōnĕyā* is rendered in the Septuagint. The Greek versions of Daniel vary, but in the forms of the texts set out by the Göttingen Septuagint. *Sumphōnia* occurs once only in the traditional Septuagint or Old Greek text (known from the *Chigi Manuscript* in the Vatican), at 3:5 (in the other three verses, 7, 10 and 15, there is mention only of the first instrument [*salpingos*, written *salpiggos*]), and not at all in Theodotion's version, universally regarded as a superior text (where only the first five instruments are mentioned in each of the four verses) (Ziegler, J., (ed.), *Septuaginta. Susanna. Daniel. Bel et Draco* [Septuaginta XVI.2] (Göttingen,1954): 114-116. In Hatch and Redpath, *Concordance*, II: 1306, which made use only of the *codices Vaticanus, Sinaiticus and Alexandrinus* and the text published under the auspices of Pope Sixtus V in 1587, they cite occurrences of *sumphōnia* at 3:5 and 15 in the Septuagint text but in all four verses in the Theodotion text, though they note that *it* is omitted at 3:5, 7, and

3:15 and Theodotion 3:5, 7 and 10 (*Music of the Sumerians:* 68. The Greek form occurs also in the New Testament in the parable of the Prodigal Son (Luke 15:25) where the elder brother returning from the fields hears '*sumphōnia* and dancing', a combination suggesting that in that context the general meaning 'music' is appropriate. A century ago Barry, P. (1904) suggested on the basis of its presumed meaning in Daniel 5 that here the meaning was 'bagpipe' ('On Luke xv. 25, *symphōnia:* Bagpipe', *JBL* 23: 180-190), a suggestion countered by Moore, G.F. (1905) *symphōnia* not a Bagpipe', *JBL* 24: 166-175; but repeated by Barry (1908) 'Daniel 35. *sūmpōnyāh*', *JBL* 27: 99-127, with a wealth of classical and later European quotations, but failing to make a convincing case for the meaning 'bagpipe'; on this see also Fitzmyer, J.A. (1985) *The Gospel According to Luke* X-XXIV [Anchor Bible 28A]. New York, London etc.: 1090.

84 *i.e. sun- > sum-* [by assimilation of *n-* to the following *ph]* + *phōnē*.

85 Montgomery, J.A. (1927-Edinburgh) *A Critical and Exegetical Commentary on the Book of Daniel:* 201, or 'harmony': 22.

86 Farmer, H.G. (1957-Oxford) (actually an Arabist more than a specialist in the ancient Near East) interprets what he transliterates as *pṣantrīn ṣūmfonyāh* as 'concord harp', taking *ṣūmfonyāh* as a noun, 'concord', in apposition to *pṣantrīn*, in Wellesz, E., (ed.), *The New Oxford History of Music* I: 245-246.

87 Goldingay, J.E. (1989-Dallas) Daniel [*Word Biblical Commentary* 30]: 65 note 5.f.

88 Glare, P.G.W., *et al.* (eds), (1976-1982-Oxford) *Oxford Latin Dictionary*, V-VIII: 1895.

89 Niemeyer, J.F., and van de Klieft, C. (2002-Leiden) *Mediae Latinitatis Lexicon Minus* II: 1268.

90 Less convincing, however, is 'pipe' (1961-Knox).

91 Vogt, E. (1971-Rome) *Lexicon Linguae Aramaicae Veteris Testamenti. Documentis Antiquis Illustratum.* Pontifical Biblical Institute: 118, with the definition '*prob. tibiae (*συμ− *suggerit tibias geminas quibus simul duo sonus emittuntur)*', citing Sellers, O.R. (1941) 'Musical Instruments of Israel', *Biblical Archaeologist* 4: 40-42, which does not mention *sūmpōnĕyā*, but suggests that '*chelil* ' may include 'double pipe').

92 The derived plural form *šĕriqôt* also has the related meanings 'whistling; piping, flute-playing' or the like (Judges 5:16, and Jeremiah 18:16 [reading *šĕrēqôt* with the Masoretic margin (Qĕrê, 'read') in place of *šĕriwqōt* of the main text (Kĕtîb, 'written')].

93 The great variety of lyres in ancient times (see Mitchell, 1992 *PEQ* 124: 137) would make the presence of two in one group a possibility. The suggested identifications of these five instruments are those proposed in Mitchell (1992) *PEQ* 124: 139.

94 Ellenbogen, M. (1962-London) *Foreign Words in the Old Testament. Their Origin and Etymology*: 122; this point is also implied by Galpin, *Music of the Sumerians:* 68.

95 For gi.gíd, sometimes written with the determinative giš, 'wood', see Borger, R. (2003-Münster) *Mesopotamisches Zeichenlexikon* [Alter Orient und Altes Testament, 305]: 281, under no.141, GI = Akkadian *qanû*, 'reed, cane'.

96 References to representations, Mitchell, (1992) *PEQ* 124: 124 (Mesopotamia) 125 (Syria, Cyprus, Anatolia). See also Schuol, *Hethitische Kultmusik*: 129, and plate references in n. 18 above; also West, *Ancient Greek Music:* pls 5-7, 9-10, 17, 21, 25, 27, 31 with: 81-2; and among Greek vase paintings of the 7th-6th centuries B.C. (selected for art historical purposes), Boardman, J. (1998-London) *Early Greek Vase Painting:* figs 178 (= West, 9), 321, 363, 414, 441, 444, 450, 485, 492.

97 In the paper Mitchell, T.C., and Joyce, R., 'The Musical Instruments in Nebuchadnezzar's Orchestra' in Wiseman *et al.*, *Notes on Some Problems*: 19-27, specifically p. 26; a suggestion I supported in *PEQ* 124 (1992): 138. The term 'tambour' is used here for simplicity to refer to what is otherwise known as a frame-drum, that is a small, usually circular, hoop, an inch or two deep, with hide stretched over it,

on one or both sides. When the hide was on both sides, a handle was necessary, but when it was on one side only, it could be held without a handle. This form, like a modern tambourine without the jingles, is the one usually shown in ancient representations.

98 See *e.g.,* Buck, C.D. (1955) *The Greek Dialects.* Chicago: 57-58 §61; as well as *Comparative Grammar of Greek and Latin* (1933-Chicago): 122-123 §141; 217 §298.1; also Palmer, L.R. (1980-London) *The Greek Language:* 60, 288; and Dosuna, J.M. (2007-Cambridge) in Christidis, A.-F. (ed.), *A History of Ancient Greek:* 446-447, 465; and Brixhe, C., in *ibid.:* 497.

99 Palmer, L.R. (1963-Oxford) *Mycenaean Greek Texts:* 42; *Greek Language*: 41; Hooker, J.T. (1980-Bristol) *Linear B. An Introduction*: 54.

100 Smyth, H.W. (1920-Harvard) *Greek Grammar:* §325; and Dosuna in Christides (ed.) (1924) *History of Ancient Greek:* 448; Cunliffe, A. (London) *Lexicon of the Homeric Dialect:* 367-368 (*su*, numerous occurrences), 392 (*tunē*, only six occurrences, 'A more or less emphatic form = *su*'); also Palmer, *Greek Language:* 60, 288 (Homeric *tunē* is tu with strengthening particle -*nē).*

101 For this form see *e.g.*, Laroche, E. (1960-Paris) *Les hiéroglyphes Hittites, I, L'écriture:* 197-198 no. 371, I. 2.

102 Koehler and Baumgartner (2001-Leiden) *Hebrew and Aramaic Lexicon* I: 770: it occurs at Joshua 13:3; Judges 3:3; 16:5,8,18,23,27,30; 1 Samuel 5:8,11; 6:4,12,16; 7:7; 29:2,6-7; 1 Chronicles 12:20.

103 For a discussion of theories about the migration of the Dorians see *e.g.,* Drews, R. (1988-Princeton) *The Coming of the Greeks. Indo-European Conquests in the Aegean and the Near East:* 203-225, with a reference to *ti > si* : 209; also Hammond, N.G.L. (1975-Cambridge) in Edwards, I.E.S., *et al.* (eds), *The Cambridge Ancient History*, II, 2: chap. XXXVI (b), specifically: 681-699.

104 Chantraine, P. (1968-Paris) *Dictionnaire étymologique de la langue Grecque*, III-IV: 1146; Frisk, H. (1970-Heidelberg) *Griechisches Etymologisches Wörterbuch* II: 946-947; for a handy summary of the changing meaning of turannos see Andrews, A. (1967-London) *The Greeks:* 61-62.

105 See *e.g.,* Mitchell, T.C., in Thomas, D.W. (1967-Oxford) (ed.), *Archaeology and Old Testament Study:* 413, 415; and Kitchen, K.A. (1973-Oxford) in Wiseman, D.J., (ed.), *Peoples of Old Testament Times:* 67.

106 The text in Lindsay, W.M., (ed.) (1911-Oxford) *Isodori Hispanensis Episcopi Etymologiarum sive Originum:* I, III, xxii, 20 [the text has no pagination], where the symphonia is the last in a passage which lists other instruments: psalterium (7), lyra (8), tympanum (10), cymbala (11), sistrum (12), and tintinabulum [de sono vocis nomen habet] (13). The connected description in this section (20) runs '*Symphonia vulgo apellatur lignum cavum ex utraque parte pelle extenta, quam virgulis hinc et inde musici feriunt, fitque in ea ex concordia gravis et acuti suavissimus cantus.*' This Latin passage is also quoted by Gesenius (*Thesaurus*: 941) and more accessibly by Sachs (*History of Musical Instruments:* 84); and is cited by Hartmann, L.F. and Di Lella, A.A. (1978-New York) *The Book of Daniel* [Anchor Bible 23]: 157.

107 On Isodore, Bishop of Seville, see Vineis, E. in Lepschy, G., (ed.) (1994-London and New York) *History of Linguistics*, II: 151-158, 320; and Reese, G. (1941-London) *Music in the Middle Ages.* With an *Introduction on the Music of Ancient Times:* 110.

108 Abegg, M., Flint, P., Ulrich, E. (1999-Edinburgh) *The Dead Sea Scrolls Bible:* 489 (in a restored passage).

109 At Genesis 31:27; Exodus 15:20 (2x); Judges 11:34; 1 Samuel 10:5; 18:6; 2 Samuel 6:5 = 1 Chronicles 13:8; Job 21:12; Psalm 81:3 (Eng 80:2); 149:3; 150:4; Isaiah 5:12; 24:8; 30:32; and Jeremiah 31 (Eng. 38):4. There is another possible reference at Ezekiel 28:13: *wĕzāhāb mĕlā'kēt tuppeykā ûnĕqabeykā*, taken by the AV and RV as 'and gold: the workmanship of thy tabrets and of thy pipes' (tabret being a tambour), but by the English Standard Version as 'and crafted in gold were your settings (*tuppeykā*) and your engravings' (with

the note 'the meaning of the Hebrew phrase is uncertain'). Brown, J.P. (1969) has pointed out that in several of these instances the *tōp* was played by women (*Vetus Testamentum* 19: 164-168, in his article 'The *Mediterranean Vocabulary of the Vine*': 146-70), but there are only three clear instances of this (Ex 15:20; Jdg. 11:34; 1 Sam 18:6; the apocryphal book of Judith (16:1) being late), while in some of the other instances the players are the wicked (Isaiah 5:12; 24:8; 30:32), so this is not a particularly significant point.

110 Set out in Dietrich, M., Loretz, O., and Sanmartín, J. (1995-Münster) *Cuneiform Alphabetic Texts from Ugarit, Ras Ibn Hani and Other Places* [Abhandlungen zur Literatur Alt-Syrian-Palästinas und Mesopotamiens 8]: 125, no.1.108, line 4 *b knr . w ṯlb . b tp . w mṣltm*, 'with lyre and pipe and tambour and cymbals'; Halayqa, I.K.H. (2008-Münster) quotes the passage with translation (taking *ṯlb* as 'flute'), *A Comparative Lexicon of Ugaritic and Canaanite* [Alter Orient und Altes Testament 340]: 102 (under the preposition b in the meaning 'with, among'). On *tp* see Del Olmo, G., Lete and Sanmartín, J. (2003-Leiden-Boston) A *Dictionary of the Ugaritic Language in the Alphabetic Traditions*, II: 874, 'drum' or 'tambourine'; also Halayqa, I.K.H., *Comparative Lexicon of Ugaritic and Canaanite:* 339; Koehler and Baumgartner (2001-Leiden) *Hebrew and Aramaic Lexicon* II: 1771-2; and on *ṯlb* see Del Olmo Lete and Sanmartín, *Dictionary of the Ugaritic Language*, II: 905, 'flute'. Concerning *tōp*, it is uncertain whether the noun was derived from the verb or vice versa. Koehler, Baumgartner *et al.* (1998-Leiden, Boston, Köln) *A Bilingual Dictionary of the Hebrew and Aramaic Old Testament.* English and German: 1037-1038) take the view that the derivation was *tp > tpp* ('*tpp* denom. v. *top*'), but Richardson (the translator and editor of Koehler, Baumgartner *et al.* (2001) *The Hebrew and Aramaic Lexicon of the Old Testament*, Study Edition II: 1779 argues that attestation of the verb but not the noun in Old Aramaic indicates that the noun probably derives from the verb. Considering the limited extent of the Old Aramaic text corpus and the fact that the noun is already attested in the second millennium at Ugarit, this point is not significant, but on the ground of probability, he may be right nevertheless, and the direction *tpp > tp* is a reasonable presumption, pending further evidence.

111 Dietrich, Loretz and Sanmartín, *Cuneiform Alphabetic Texts from Ugarit*: 128-129, no. 1. 113, a tablet which has part of a king list on the reverse; K.L. Younger in W.W. Hallo and K.L. Younger (eds) (1997-Leiden) *The Context of Scripture, I, Canonical Compositions from the Biblical World:* 356-357 no. 1.104 discussion of the king list in Kitchen, K.A. (1977) 'The King List of Ugarit', *Ugarit Forschung* 9: 131-142, with comments on the obverse and the musical element in it: 139-140.

112 Or, with Kitchen, 'and high is the sound of his tambourine' and 'and high is the sound of the flutes', but preferring tambour and pipes.

113 Sefire Inscription, III, line 13: A. Dupont-Sommer (1956) 'Une inscription araméenne inédite de Sfiré', *Bulletin du Musée de Beyrouth*, 13: 23-41, specifically 27 (transcription), 29 (translation), 33 (comment: plural imperative, with pronominal suffix (-*h*), of root *tpp*, 'frapper'), pls II (copy), III (photograph in which the reading *tpwh* is clear).

114 Donner, H., and Röllig, W. (1962-Wiesbaden)-4 *Kanaanäische und aramäische Inschriften:* no. 224: 44 (reading *tpwh bḥrb*) 269 (assuming a scribal error for *tkwh* for grammatical reasons, though accepting the possibility (with Dupont-Sommer) that *tpwh* from a verb *tpp* might be correct), pl. XXIII (copy); Fitzmyer, J.A., (1967-Rome) The Aramaic Inscriptions of Sefire [*Biblica et Orientalia* 19]: 98-99 (proposing a reading *tkwh bḥrb*), (accepting that the reading *tpwh* 'is certain', but taking it as an engraver's error since the verb *nkh*, 'strike' occurs in the form tkh later in the same line); Degen, R. (1969) *Altaramäische Grammatik. Der Inschriften des 10.-8. Jh. V. Chr.* Wiesbaden: 73 §58 with n. 68, 80 §65 (c) and (d) (reading *tpwh*, and assuming *tph* instead of tkh later in the line); Gibson, J.C.L. (1975-Oxford) *Syrian Semitic Inscriptio*ns, II, Aramaic Inscriptions: 48-49 (transliteration and translation, reading *tpwh bḥrb*),

54 (the *p* in *tpwh* is certain, but is probably a scribal error for *nkwh* because the verb *nky*, 'to strike' occurs later in the line), 190, fig. 4 (copy).

115 Lidzbarski, M. (1915-Giessen) '*Reisefrüchte aus dem Orient. I, Die phönizischen und aramäischen Inschriften in der Tempeln von Abydon in Ägypten*', *Ephemeris für Semitische Epigraphik*, III: 93-116, specifically 97 no. G = *Répertoire de l'épigraphie Sémitique, publié par la Commission du Corpus Semiticarum III* (1916-1918-Paris) no. 1302, specifically 1322 = Donner and Röllig, *Inschriften, no. 49.7*.

116 References in Mitchell (1992) *PEQ* 24: 124 under (i) in the table.

117 References in Mitchell (1992) *PEQ* 124: 126, nos 33-37; also Orthmann, W. (1971-Bonn) *Untersuchungen zur späthethitischen Kunst:* 393-394 with photographic plates; also Schuol, *Hethitische Kultmusik:* pls 33-39, 13-16, and 22 (Egypt), 31 (Babylonia), 35 (Assyria).

118 Mitchell (1992) *PEQ* 124: 128.

119 At Genesis 31:27; Exodus 15:20 (2x); Judges 11:34; 1 Kings (Eng. 1 Samuel) 10:5; 18:6; 2 Kings (Eng. 2 Samuel) 6:5 = 1 Chronicles 13:8; Psalm 80:2 (Heb 81:3); 149:3; 150:4; Isaiah 5:12; 24:8; 30:32; and Jeremiah 38 (Heb 31):4, but Job 21:12 has psalterion for *tōp*, in other words in all but one of the passages listed in n.109 above; while this is the usual rendering at Isaiah 30:32 some manuscripts (Alexandrinus and Sinaiticus, but not Vaticanus) have aulos for *tōp* there. *Tumpanon* occurs also in the Apocryphal books at 1 Esdras 5:2; Judith 3:7; 16:2; 1 Maccabees 9:39; and 2 Maccabees 6:19; 28.

120 The similarity between Greek *tumpanon* and Semitic *tp* raises the question of a possible relationship between them. Borrowing in each direction has been proposed (Semitic > Greek (*e.g.*, E. Masson, (1967-Paris) *Recherches sur les plus anciens emprunts sémitiques en grec.*: 94-5); Greek > Semitic (*e.g.*, Brown, J.P. (1969) 'The Mediterranean Vocabulary of the Vine', *Vetus Testamentum* 19: 146-170, specifically 164-8, suggesting that the verb was derived from the noun and arguing that 'Hebrew usage suggests that *toph* is foreign, and there is no good evidence for an original root *tpp*', but offering no supporting data, and dismissing the Ugaritic and Old Aramaic evidence as 'obscure', so his argument is not convincing).

121 West rightly points to the distinction (*Ancient Greek Music:* 124).

122 *Bakkhae* 59: 'you who have left Mount Tmolus, Lydia's defence, my company, you women whom I have brought from the barbarians to consort with me as we travel together, lift the drums (*tumpana*) which come from their home in a Phrygian city, the invention of mother Rhea and myself', translation by Morwood, J. (1999-Oxford) *Euripides, Bacchae and other Plays:* 46; Greek text and loose translation in A.S. Way (1912-London and Cambridge) *Euripides*, III [Loeb]: 10-1 (with 'cymbals' for *tumpana*).

123 See *e.g.*, Allen, T.W., Halliday, W.R., and Sykes, E.E. (1926-Oxford) *The Homeric Hymns*. 2nd ed.: cix (in general the hymns probably date from the last stage of the Epic period [7th-6th century B.C.]), 394-395 (concerning no. 14, quite Homeric, and not as late as Orphic [c. mid-6th century B.C. onwards]); Janko, R. (1982-Cambridge) *Homer, Hesiod and the Hymns:* 200 (tentative chronological chart placing the main hymns between c. 700 and 585 B.C., but he does not deal specifically with no.14); Rayor, D.J. (2004-Berkeley) *The Homeric Hymns:* 2 (most written c. 700-500 B.C., but no specific reference to the date of no. 14).

124 Conveniently shown in *An Intermediate Greek-English Lexicon Founded upon the Seventh Edition of Liddell and Scott's Greek-Lexicon* (1889-Oxford): 824, 'τυπτω (Root ΤΥΠ), to beat, strike, smite'.

125 Ebeling, H., (ed.) (1880-London and Paris) *Lexicon Homericum*, II: 352; Cunliffe, *Lexicon of the Homeric Dialect*: 392; as well as the useful small volume of Autenrieth, G. (1877-London and New York) *An Homeric Dictionary for the Use of Schools and Colleges:* 310.

126 Chantraine, P. V. (Paris) *Dictionnaire étymologique de la langue Grecque*,

III-IV: 1145-1146; Frisk, H. (1970-Heidelberg) *Griechisches Etymologisches Wörterbuch*, II: 945-947.

127 See *e.g.,* Comotti, G. (1991-Baltimore and London) *Music in Greek and Roman Culture:* 57, and 74-75 (on *tumpanon*).

128 Mentioned in a list of the deities of the Hittite Empire which forms part of a prayer of Muwatalli II (1295-1272 B.C.): translation of the list by Gurney, O.R. (1959-London) in J. Garstang and Gurney, *The Geography of the Hittite Empire:* 116-119, specifically 116, line I. 53 (Kupapa); mentioned by Gurney, Hittite Religion: 17; translation of the Prayer without the list by Goetze, A. (1969-Princeton) in Pritchard, J.B., (ed.), *Ancient Near Eastern Texts Relating to the Old Testament*. 3rd ed.: 397-399.

129 Useful discussion by E. Laroche (1960-Paris) 'Koubaba, déesse Anatolienne, et le problème des origines de Cybèle' in *Éléments orientaux dans la religion grecque ancienne* [Colloque de Strasbourg 1958]: 113-128; see also Goetze, A. (1957-Munich) Kleinasien: 205-206; and for some aspects of the goddess and Phrygian religion see Barnett, R.D., 'Phrygia and the Peoples of Anatolia in the Iron Age' in Edwards *et al.* (eds), *Cambridge Ancient History*, II, 2, chap. XXX, specifically: 435-438.

130 Bittel, K. (1970-Oxford) Hattusha. *The Capital of the Hittites:* 150-3, pl. 29, fig. 36; Schuol, *Hethitische Kultmusik*: 77.

131 Laroche, '*Koubaba, déesse Anatolienne*': 123-125.

132 References in Mitchell (1992) *PEQ* 124: 125-6, the tambour specifically 126, nos 33-37; also Orthmann, *Untersuchungen zur späthethitischen Kunst*: 393-394 with photographic plates.

133 Account of this event in Livy, *History of Rome* 29.14:10-14; quoted also in Shelton, J.-A. (1988-Oxford) *As the Romans Did. A Sourcebook in Roman Social History:* 401-402; see also Dumézil, G. V. (Baltimore and London) *Archaic Roman Religion* 2: 484-489.

134 Account of a procession in Lucretius, *De Rerum Natura*, 2:594-632; selections (2:594-601, 606-614, 618-632) in Shelton, *As the Romans Did*: 402-403; see also Cumont, F. (1911-New York) *Oriental Religions in Roman Paganism;* reprinted (1956-New York (Dover)): 47-53, specifically 49; Catullus (c. 84-c. 54 B.C.), Poem 63 (Attis), recent translation in Burl, A. (2004-London) Catullus. *A Poet in the Rome of Julius Caesar:* 241-3, and on Cybele: 165-167, 170.

135 Lucretius 2.619; Catullus 63:9-11; Vergil, Aenead, 9:619; Ovid, Metamorphoses, 3:537; 4:29; 391; Plautus, Poenulus, 5:5,38.

136 Now in the Capitoline Museum, Rome, no. 987; see Helbig, W. (1966-Tübingen) *Führer durch die öffentlichen Sammlungen klassischer Altertümer in Rom*, II. 4th ed. by H. Speier: 25-6 no. 1176 [I am indebted to Dr Thorsten Opper for directing me to this publication]; reproduced in Ferguson, J. (1970-London and New York) *The Religions of the Roman Empire:* pl. 5, with: 26-31.

137 At Genesis 31:27; Exodus 15:20 (2x); Judges 11:34; 1 Kings (Eng. 1 Samuel) 10:5; 18:6; 2 Kings (Eng. 2 Samuel) 6:5 = 1 Chronicles 13:8; Job 21:12; Psalm 80:2 (Heb 81:3); 149:3; 150:4; Isaiah 5:12; 4:8; 30:32; and Jeremiah 38 (Heb 31):4, in other words in all of the passages listed in n.109 above, including Job 21:12.

138 See no. 106 above.

139 See also Sachs, *History of Musical Instruments:* 141.

140 *tibbuttu, timbuttu, timbūtu, tibbutu, tibbūtu, tibutu, tibūtu,* as well as *tubbutu, tambūtu, timbu'u, tibbu'u, tibu'u* (*CAD*, 18, T (2006-Chicago)): 417-418; Black, J., George, A., Postgate, N., (eds) (2000-Wiesbaden) *A Concise Dictionary of Akkadian.* 2nd pr: 405). The form *tibu´u* occurs in one religious text in the passage *tibu'u ḫal-ḫa <la>-at narām* DINGIR-*ti-ki*, 'the *tibu'u* and the *ḫalḫallatu*, beloved of your godhead', interpreted by the Chicago Assyrian Dictionary as 'the *tibu'u*-harp and the *ḫalḫallatu*-drum, beloved of your godhead', where the *ḫalḫallatu* was a kind of drum made of metal with a hide cover (*CAD*, 6, Ḫ: 41 ('a kind of drum'); on *ḫalḫallatu* see also Kilmer, A. (1993-97-Berlin) in *Reallexikon der Assyriologie*, 8: 465.

141 *CAD*, 18, T: 417.

142 Black, George, Postgate (2007-Helsinki) *Concise Dictionary of Akkadian*: 405; Parpola, S., (et al. eds), *Assyrian-English-Assyrian Dictionary:* 125.

143 Restored from [giš.bal]ag.di = *tim-bu-ut-tum* in the lexical list (of equivalents) ḪAR.RA = *ḫubullu* (= 'debt, interest') VII B 40 (This is transliterated in *Materialien zum Sumerischen Lexikon* 6 (1958-Rome) [hereafter *MSL*]: 120, as [giš.dú]b.di = *tim-bu-ut-tum*, balaĝ and dúb being different readings of the same sign [read there as dúb.di on the basis of the variant ^giš^dúb-dúb-di which has the gloss bu-ud-bu-da-di (note on p. 120)); and g[iš.balaĝ.di] = [. . .] = *tim-bu-ut-tum* in the lexical list ḪAR.GUD = *imrû* = *ballu* (= 'fodder') = g B II 195 in (*MSL*, 6 (1958): 143).

144 Restored from kuš.balaĝ.di = MIN *tim-bu-tu* (where MIN (ditto) refers to Akkadian *mašak*, 'hide' higher in the column)) in ḪAR.RA = *ḫubullu* XI 266, (see MSL 9 1967: 201).

145 Or balaĝ (balang).

146 Anderson, R.D. (1976-London) *Catalogue of the Egyptian Antiquities in the British Museum, III, Musical Instruments:* 78-80 no. 108; see also another of wood only: 75-6 no. 106 (BM.E.6382), with drawing, fig. 138, showing it restored with skin or hide. A similar use of skin for the sound table is found in traditional African harps, see *e.g.,* DeVale, S.C., in Sadie, E., (ed.) (2001-London) *The New Grove Dictionary of Music and Musicians*, Second Edition 10: 890 with fig. 11 (in 'Harp, III').

147 Oberhuber, K. (1990-Innsbruck) *Sumerisches Lexikon:* 53 ('*bal-angu*-Harfe'); Borger, *Mesopotamisches Zeichenlexikon*: 367 no. 565 ('eine Art Harfe'); Halloran, J.A. (2006-Los Angeles) *Sumerian Lexicon. A Dictionary Guide to the Ancient Sumerian Language.* [a compilation from other lexical publications]: 29 ('(spoon-shaped) round-harp, a drummable resonator, with a croaking/tweeting sound associated with frogs, crickets/locusts, and the sparrow'); the third millennium pictographic forerunners of the cuneiform sign balag could represent a kind of harp, but somewhat less so by the later third millennium (see conveniently selected examples in Labat, R. (1976-Paris) *Manuel d'épigraphie Akkadienne.* (New ed. by Malbran-Labat, F.,), no. 352, columns I and II), but in the course of nearly two thousand years, the meaning could well have changed.

148 Deimel, A. (1934-Rome) *Šumerisches Glossar,* III, *Šumerisch-Akkadisches Glossar:* 25 ('ein paukenartiges Musikinstrument', with p. 24 (bal = 'schlagen')); Gadd, C.J. (1924-Oxford) A *Sumerian Reading Book:* 179 ('drum, timbrel, or possibly lyre (?)'); and the sense 'drum' has also been suggested for *balaggu*, the form borrowed in Akkadian, Black, George, Postgate, *Concise Dictionary of Akkadian*: 36 *s.v. bal-angu*, '(a large drum)'.

149 *CAD*, 2, B: 38-39. Here and in other dictionary citations, parentheses within the quoted definition indicate uncertainty.

150 Kilmer, A.D. (1993-1997-Berlin) in her entry 'Musik A.I' in *Reallexikon der Assyriologie und Vorderasiatischen Archäologie* 8: 463-482, specifically: 465; and more confidently in Sadie (ed.) (2001) *New Grove Dictionary of Music and Musicians:* 484, 'The BALAG = *balaggu*, which served as both harp and drum, had a broad soundbox serving as a resonator' (in '*Mesopotamia*' §5).

151 *CAD*, 18, T (2006): 417; though it is not included in Gelb, I.J. (1957-Chicago), Glossary of Old Akkadian [*Materials for the Assyrian Dictionary* 3].

152 See note 116 above.

153 See note 117 above.

PLAYING IN CONCERT
IN THE
ANCIENT NEAR EAST

Dominique Collon

This paper focuses on depictions of groups of musicians playing together. The evidence selected comes predominantly from Mesopotamia (including Syria and south-western Iran) and Anatolia, between c. 3100 B.C. and c. 645 B.C. We shall only consider scenes showing groups of musicians playing musical instruments of different types.[1] Men and women performers have not been distinguished because gender is often ambiguous (eunuchs, castrati etc), as the first document in our series amply demonstrates; where there is ambiguity, rather than use 'he/she', the figure will be treated as masculine. The documents selected are numbered for ease of reference and are arranged in probable chronological order.

The late Fourth Millennium and the first half of the Third Millennium B.C.

Fig. 1

1. Probably the earliest group of musicians fitting these criteria is depicted on a cylinder seal impression on a clay door-sealing from Choga-Mish in south-western Iran.[2] Only the silhouette of the figures and objects is visible, and this is a feature of the seal's 'baggy' style. Dated parallels from Uruk and south-western Iran indicate a date no later than c. 3100 B.C.

Four musicians are seated on the ground in a group, each with one knee raised. All but one face a figure seated in the same posture but differentiated by hairstyle, perhaps indicating a woman, and by the fact that she is elevated on what appears to be a large cushion; she seems to be choosing between a triple vessel[3] and a small spouted vessel offered to her by a possibly naked attendant, while before her is a stand for small jars. A large fish, or more probably a tilted amphora (perhaps on a small cushion), a circular dish with handles, depicted as though propped on its side, a large jar with upright loop-handles,[4] and a small jar with pointed base, occupy the upper field,[5] and small cups are scattered around.

This is clearly a banquet – a subject that was to be repeated over the millennia, almost always with musical accompaniment. Among the musicians is possibly the earliest depiction of a harpist, who plays a vertical harp.[6] A figure with his hand held to his mouth or throat may be a singer. The next figure is probably holding clappers which were a common instrument played at banquets in the third millennium (see nos 4 and 5). Facing them is a drummer before a low drum, who is beating the rhythm for the group with the flat of his hand.

Fig. 2a
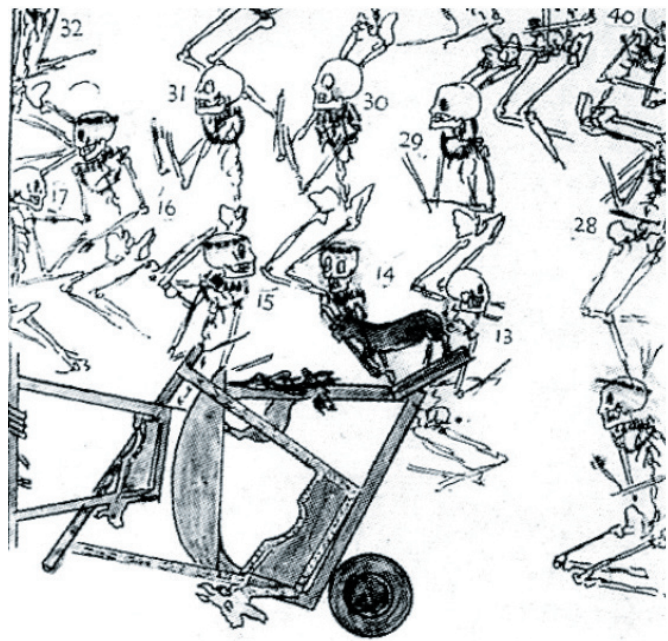
Fig. 2b

2. Music seems to have accompanied the final hours of the 6 men and 68 women buried in the Great Death Pit in the Royal Cemetery at Ur (P.G. 1237), c. 2600 B.C.

There is some debate as to whether the bodies lie where they had fallen after ingesting a fatal drug, or whether they were killed elsewhere with a blow to the head, after which their bodies were heated for preservation before being laid out in the neat rows illustrated by the excavator.[7] Unfortunately the preserved skeletal remains are few and may not be representative.

This argument has no bearing on the fact that three musical instruments were found (fig. 2a and b), together with the skeletal remains of a group of presumed musicians identifiable as women by their floral headdresses – four alongside the instruments and one on her own in front (fig. 2a). The preservation of the instruments was due to Woolley's pouring plaster of Paris into hollow spaces in the ground left by the decomposed wood. This recorded the shape of the instruments and the position of the mosaic strips and panels that had decorated the instruments.

The instruments were divided between the British Museum in London: the silver bull-lyre BM ME 121199,[8] (fig. 2c); the University Museum in Philadelphia: a boat-lyre with a goat UM 30-12-253,[9] (fig. 2d); and the Iraq Museum in Baghdad IM 8694: the gold bull-lyre,[10] (fig. 2e).
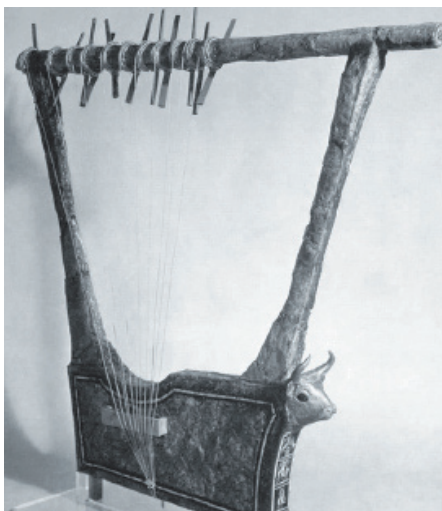
Fig. 2c
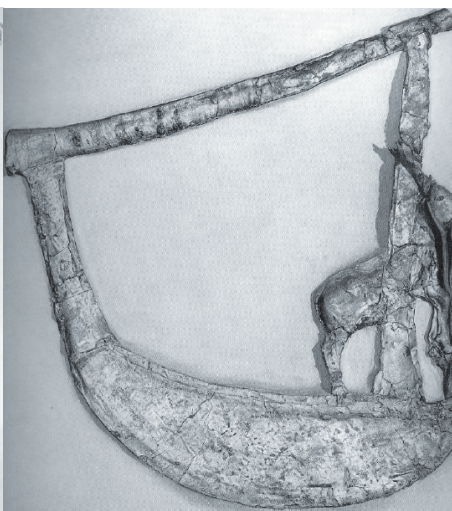
Fig. 2d

Fig. 2e
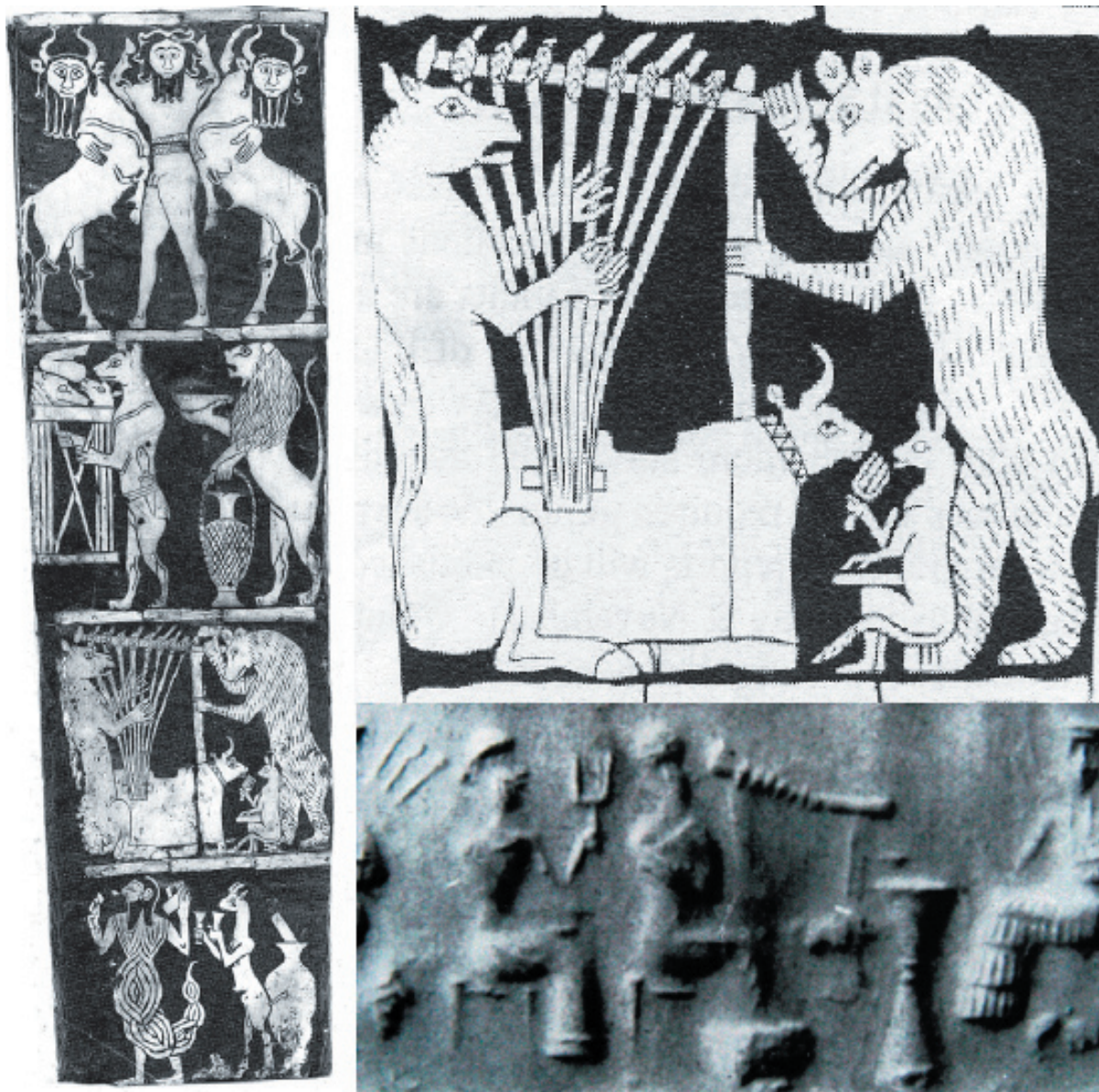
Left, fig. 3a; top right, 3b; bottom, fig. 3c

3. A mosaic panel decorating a lyre, from grave P.G. 789 in the Royal Cemetery at Ur,[11] depicts animal attendants and musicians at a banquet that is not depicted (c. 2600 B.C.).

The scene is divided into four registers of shell plaques set into a bitumen background (fig. 3a), of which the lower three show animals standing on their hind legs or sitting in human posture. At the top of these, a jackal brings a light table on which meat is set, followed by a lion carrying a jar set in basketry, like a Chianti bottle.

The middle register (fig. 3b) shows an ass sitting and playing a large bull-lyre (*cf.* no. 4); before him stands a dancing bear that either holds the lyre or, more probably in the writer's opinion, claps its paws as it dances. In front of the bear sits a small animal with a sistrum and sounding board. Uri Gabbay demonstrated that the combination of the two instruments can be traced right through to Hellenistic times (fig. 3c).[12] The bottom register shows a scorpion-man acting as major domo and seeming to call for silence before a speech, while a goat brings tall cups that it has filled from a large jar in the background. This and a contemporary seal impression from Ur,[13] are perhaps the earliest objects that depict the association of animals and music – an association that continued sporadically in the Near East throughout antiquity, and is found in numerous Romanesque churches and, more recently, in the story recorded by the Brothers Grimm as the 'Musicians of Bremen'.

Fig. 4

4. A cylinder seal from the Royal Cemetery of Ur (c. 2600 B.C.) is made of a bitumen core covered in gold (the seam-line is visible) that is decorated in repoussé.[14] The design represents a banquet scene in two registers separated by a pair of horizontal lines. Above, a seated couple face each other and hold cups which attendants have handed to them. The banqueter on the left is a man, that on the right is a woman, judging by her hairstyle, and she is depicted at a larger scale. Between the two groups is a high offering table with cups and perhaps bread on it. These four figures, together with the four in the lower register, probably wear sheepskin garments with fringes of wool hanging below the skirt (see also no. 5).

The scene in the lower register shows two women facing left, each holding a pair of clappers. Between them is a woman, perhaps clapping. A large bull-lyre is played by a man seated on a square stool; this group is placed beneath the major figure of the upper register.

Fig. 5

5. The drawing shows a reconstruction of the design on a cylinder seal[15] (fig. 5; height 4.6 cm) that was rolled out on a probable door-sealing from Mari on the Middle Euphrates in Syria (c. 2550 B.C.).

The seal design was divided into three registers by two pairs of horizontal lines. On the top register is a seated woman, presumably the owner of the seal, who faces left, wears a bordered veil over her head, raises a cup and may hold a branch in her left hand. Her seat has vertical struts and behind her is an attendant who is probably holding a parasol, judging by other parallels from Mari.[16] To the right of this attendant is a panel with an inscription arranged in vertical lines but difficult to read. It identifies the owner of the seal as the wife of the EN (ruler) of Mari; the small figure of a man, in a knee-length garment, faces left towards the inscription and seems to hold its frame. In front of the seal owner there seems to be an attendant facing left towards another seated figure, probably a man as on the Ur seal (no. 4).

The middle register depicts musicians both taking part in and accompanying the banquet. The main scene shows two seated figures facing each other on seats with vertical struts. That on the right is damaged, but may be a woman as there are indistinct remains of what may be a child standing by her knees; behind her is the fringed skirt of a standing attendant. The other seated figure is a woman and the evidence seemed to suggest that she was turning back towards the left to strike the clapper of a figure standing behind her; that figure has her hair in a waist-length pig-tail hanging from the top of her head. Further left there is a vertical harp and a hand holding it. Between the seated figures is another woman with a similar long pigtail, facing left and playing a small portable lyre.

The bottom register shows a figure with a similar pig-tail with a hand or hands raised, facing left; by analogy with the two figures who follow her, she may be clapping, but she wears a longer garment that may be plain. To the right is another group of three figures: a female player of a vertical harp, and two pig-tailed figures facing each other, each holding a single clapper with which they strike the other's clapper. With the possible exception of the figure to the right of the inscription, wherever the bottom of a garment is preserved, it has a fringed hem – probably the wool hanging below a sheepskin garment with the fleece side in (see no. 4).

It is interesting to compare numbers 4 and 5, both depicting similar banquets and women with clappers, but whereas on the Ur seal the women hold two clappers which they strike together independently of each other, on the Mari sealing the women only hold one clapper and strike the clapper of the person facing them (in the middle register the seated figure even turns in her seat to do so).

The Second Millennium B.C.

Fig. 6

6. Drawing of the design on an Old Babylonian cylinder seal from 'Usiye, on the Middle Euphrates in Syria.[17] The composition harks back to Akkadian seals where worshippers approach seated deities, and where the bull-man often appears.

It depicts a large player of a lyre and a small player of what appears to be an early representation of an angular harp,[18] where the ends of the strings, instead of hanging vertically, project horizontally towards the seated deity who faces them and holds a branch with leaves or an ear of wheat.

Fig. 7

7. Old Babylonian terracottas often depict musicians but here two are shown playing different instruments, probably in the context of some type of popular religious festival.

A naked woman stands and plays a portable lyre and a male acrobat or dancer, probably wearing a belted kilt, plays the tambour before her (see no. 9 for a similar figure). This is an unusual reversal of roles, since normally it is women who play the tambour, and men who play the lyre. However, by analogy with number 9, the man may be holding a ball – in which case he should not be included here as a musician!
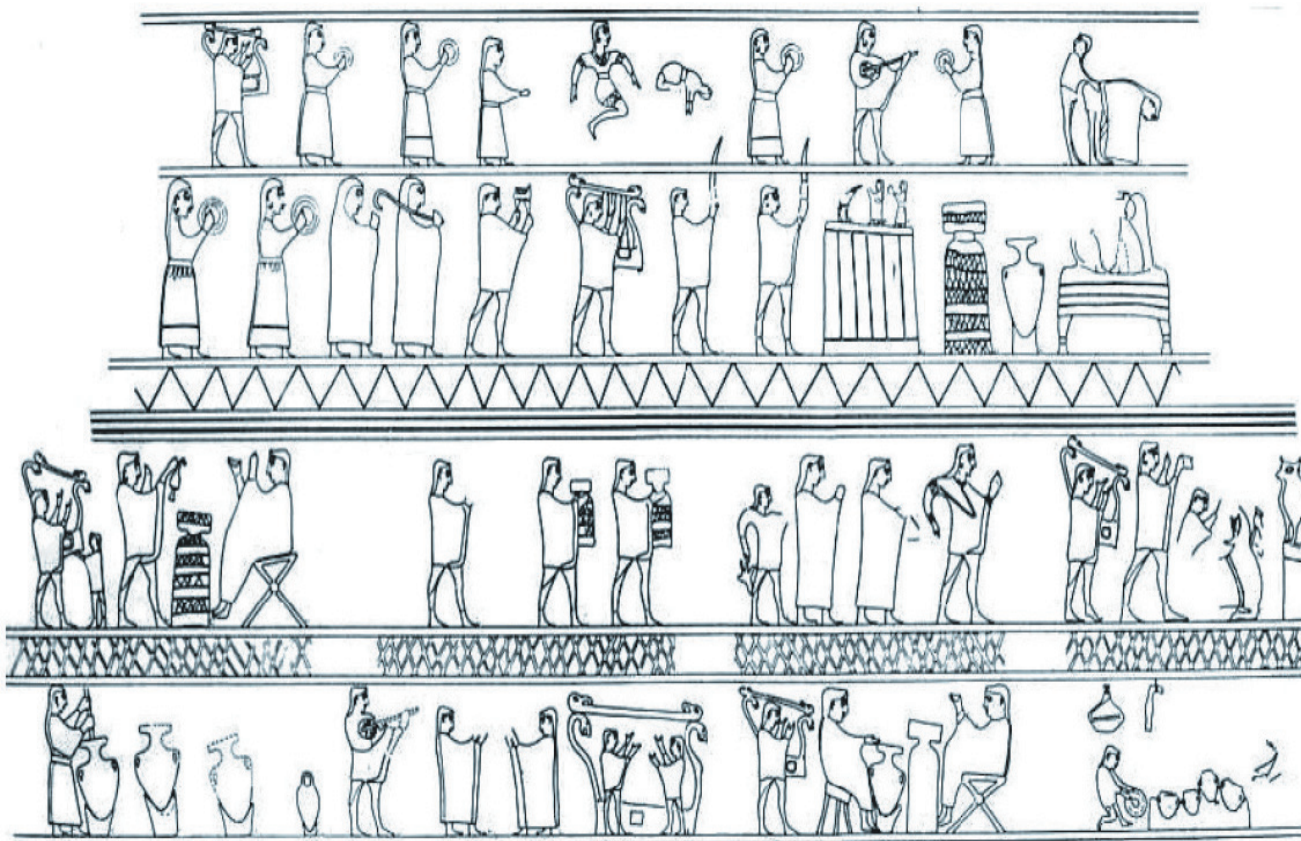
Fig. 8

8. An Old Hittite (c. 1650 B.C.) relief vase was found at İnandık in central Turkey. The relief decoration appears in four bands of figures in white and black against a reddish-brown background.[19]

The scene depicts a ritual marriage accompanied by processions and religious ceremonies, acrobats, anal intercourse, preparations of food and drink and a ritual meal, accompanied by five musicians playing portable lyres, two musicians playing a single large free-standing lyre, six musicians playing tambours or cymbals (the scale is too small for this to be clear), and two lute-players. It is interesting that there are no harps, drums or wind instruments.

Fig. 9

9. A Mitannian cylinder seal (c. 1400 B.C.) of blue faience (2.3 x 1.17 cm) was excavated at Tell Atchana (ancient Alalakh) on the Syrian-Turkish frontier between Antakya and Aleppo.[20]

It depicts a seated deity holding a small vase, who is approached by an interceding goddess. A group of performers completes the scene: a naked female figure raises a tambour and faces a robed female figure who holds a vertical harp with tassels below; this type of harp was to become popular in the first millennium B.C. (see nos 18, 20 and 21). Between them is a small acrobat or dancer, probably naked, who seems to be doing tricks with a ball (see no. 7).

There is another coiled snake on the top below which there are two registers, the upper one with the symbols of deities.

The lower register depicts a procession of seven male lute players who carry bow-cases and alternate with horned animals: they follow a dancing woman who looks back at them, or at a huge tub in which is a plant with three globular flowers or fruit. She carries a bow-case, plays a tambour and follows a lion – the attribute animal of Ishtar. She may, therefore, be Ishtar in her guise as goddess of war, or a priestess representing her. The men may be shepherds, soldiers, or both – perhaps the commissariat of the Babylonian army, perhaps associated in some way with the fortress below. However, the scene is without parallel and the inscription that might have provided information was never cut.

The first third of the First Millennium B.C.

Fig. 12

12. A relief sculpture (c. 865 B.C.) from the Throne Room in the North-West Palace of the Assyrian king Ashurnasirpal II at Nimrud shows soldiers celebrating after a military victory. They hold the heads of decapitated enemies as they dance to the sound of music played by a lutanist, by two harpists on horizontal harps and by a man with a tambour that hangs across his chest. Two priests wearing lion skins seem to be dancing: one is clapping and the other holds a whip and may be singing. In a lower register the scene is continued with soldiers tossing enemy heads backwards and forwards to each other like balls.

Fig. 13 a   Fig. 13 b

13. These bas-reliefs from Karatepe, north of Adana in southern Turkey, formed one of two scenes showing musicians at a banquet, carved in different styles (*cf.* no. 15). This pair, in the earlier style of c. 850 B.C., seems to have been moved from the nearby site of Domuz Tepe. However, when erected at Karatepe the pairs were confused so these earlier musicians were erected alongside the later banquet and vice versa. Here the two scenes have been reconstructed, so that the 'chinless' figures of the earlier style are shown together as originally intended.[23]

The musicians consist of a tambour player on the upper register between two larger figures who hold a pierced disc between them; it is not clear what this disc may be. On the lower register is a lyre player using a plectrum, a dancer, a small figure (perhaps an acrobat), and a player of long double-pipes.

Fig. 14

14. Reconstruction of the fragmentary scene on an ivory pyxis in Syrian style (c. 800 B.C.) excavated at Nimrud.[24] It shows the lower part of an enthroned figure in a garden who holds a cup and faces an offering table piled with food presented by a small attendant on a raised platform; a further attendant probably brought drink.

Behind the enthroned figure is a group of musicians standing between two stylized plants.

These musicians wear various types of dress, two play double flutes, one strikes a tambour, and two play chalcophones[25] and look outwards (one seems to be dancing, but the legs of the other are missing), and of a final figure only the skirt remains.

Fig. 15 a

Fig. 15 b-c

15. These bas-reliefs from Karatepe, north of Adana in southern Turkey, formed one of two scenes showing musicians at a banquet, carved in different styles (*cf.* no. 13). These are in the later style of c. 745 B.C.[26] The one on the left (fig. 15a) was erected alongside an earlier banquet (fig. 13b),[27] and separately from the other two (fig. 15b and c that form one scene), but the three reliefs may have originally belonged together. All the figures on figure 15a face right and on the upper register attendants bring food and drink for the banquet on the next relief. The musicians on the lower register consist of a tambour player, two musicians playing different types of lyre (with the player on the right using a plectrum), and a player of double-pipes. Another player of double pipes appears below the table on the left of figure 15c.

Fig. 16 a

Fig. 16 b

16. Two reliefs were excavated from the Processional Entry at Carchemish (c. 740 B.C.), on the Euphrates at the Turco-Syrian border.[28]

They depict respectively a lutanist, a player of long double pipes, a player of small cymbals and a dancer (fig. 16a); and a horn player and three drummers playing a large drum or gong that hangs vertically from the necks of two of them, while a third stands between them and behind the drum (fig. 16b).

Fig. 17 a-d

17. A whole sequence of relief sculptures depicting a procession was recovered from both sides of a descending passageway or ramp linking Sennacherib's South-West Palace at Nineveh with the Ishtar Temple (c. 700 B.C.). All the figures are processing from right to left. Sennacherib, the crown prince, courtiers, attendants and bodyguard march uphill towards the palace.

The musicians, on the other side of the passage, procede on the level and downhill.[29] First comes a group of male musicians following soldiers who move on the level on two adjacent reliefs.

The first part, (fig. 17a and b), is preserved and consists of three bearded men with shoulder-length hair who play frame-drums: they are wearing fringed robes and shawls, and are followed by a woman playing small cymbals and a second woman carrying a large tambour or drum on her shoulder. The third relief is only preserved as a drawing (fig. 17c) and it is not certain that it followed immediately after figure 17b. It does, however, show a continuation of women percussionists playing two tambours and small cymbals, and all the women are depicted in increasing size, emphasizing the downward slope (not indicated in the drawings but clear in the case the preserved relief fig. 17b). Behind the women are parts of two horizontal harps that continue onto the next relief (partly preserved; fig. 17d) that shows that there were two pairs of harpists, each consisting of a bearded man and a clean-shaven man wearing a tall headdress ending in what resembles a fish-tail (only one fully preserved).

Fig. 18

18. Detail of a relief sequence from Room E of the North Palace of Ashurbanipal at Nineveh (c. 645 B.C.), depicting two clean-shaven priests, possibly eunuchs, and attendants leading dogs, in a garden full of trees, vines, flowers and tranquil (drugged?) lions.[30]

Both the priests move towards the right, and have Assyrian hairstyles. One of them wears a feathered headdress and a plain robe with a thick belt, and he plays a lyre. The other wears a beaded band around his head that hangs down behind, and a plain robe with a fringed hem, and plays a vertical harp. A further fragment (BM ME 127370) shows a head with a similar beaded band, perhaps belonging to a third musician.

Fig. 19

19. Detail of a relief fallen from an upper storey into Ascending Passage R of the North Palace of Ashurbanipal at Nineveh (c .645 B.C.). It shows defeated Elamite allies of the Chaldaeans. On the second register of a four-register sequence of reliefs there are four musicians.

The musicians are facing each other in pairs, they are dancing and they wear belted robes with fringed hems and, judging from their braided locks, they are probably foreigners. They play two types of lyre, a tambour and cymbals.[31] Barnett believes they are 'playing and performing a triumphal dance', implying that they are Assyrians, but their hairstyle is not Assyrian so this seems unlikely.

Fig. 20 a and 21 a (details)

20. Elamite prisoners procede along the banks of the river Ulai which is choked with their dead. Details from the lower register of the relief sequence showing scenes from the Battle of the River Ulai under Ashurbanipal, carved c. 645 B.C. in Room 33 of Sennacherib's South-West Palace at Nineveh.[32] The procession consists of inhabitants of the city of Madaktu who are welcoming their new ruler, a renegade Elamite.

The procession is led (fig. 20a) by male musicians: seven playing vertical harps of various sizes and types, one playing a horizontal harp, two playing short double pipes and one playing long double pipes and one playing a long drum (in front of the last harpist; *cf.* fig. 21). They are followed by wailing, ululating and clapping women, accompanied by children who are also clapping (fig. 20b – note the overlap with fig. 20a).

Fig. 20 a - 20b

Fig. 20 b (continued)

Fig. 21a

21. Photomontage of a series of bas-reliefs from the North Palace of Ashurbanipal at Nineveh (c. 645 B.C.) depicting an orchestra playing in the garden of his harem.[33] The reliefs had fallen from an upper storey into Room S.

The main scene is the famous 'Garden Party' relief showing the reclining king feasting with his enthroned queen (the earliest datable example of a reclining banquet), combined with other fragments of reliefs, and drawings made at the time of discovery. The musicians are women and beardless men (as this is the harem, they must be eunuchs), and they play a total of six vertical harps, one lyre, one lute, one long drum (see p. 61, details of figs 20a and and 21b), three short double pipes and six long double pipes (the long double pipes are all held by beardless men – see fig. 21c). A fragment in Berlin shows a female flautist.[34]
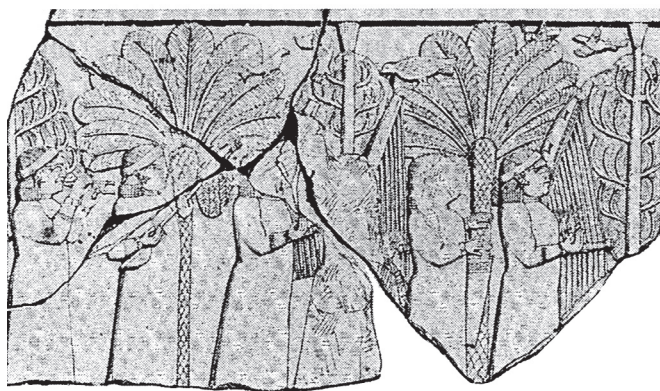
Fig. 21b

Fig. 21c

Conclusions

The five earliest documents included in this survey range in date from c. 3100 B.C. to c. 2550 B.C. All either depict banquets or are associated with banquets, including a funerary meal and an animal banquet (nos 2 and 3). Bull-lyres of different types and sizes, and harps are the most frequent instruments played with other instruments. Clappers are also played with other instruments at this period but at no other (nos 1, 4 and 5). Although musicians are depicted during the second half of the 3rd millennium B.C., they are not shown in groups apart from the Akkadian seal illustrated in connection with number 3 (see fig. 3c). The next six documents are far less homogeneous, although musicians face deities on numbers 6, 9 and perhaps 11, and acrobats appear on numbers 7, 8 and 9. The lute was known as a solo instrument from at least the Akkadian period (c. 2300 B.C.), and perhaps much longer (Collon 1987/2005, nos 672-3; and see the tentative suggestion discussed in Collon 2001, dating to c. 3100 B.C.), but here for the first time there are depictions of groups of lutanists (nos 8 and 11), although a solo player also occurs (no. 10). Lyres of different types and sizes are depicted (nos 6, 7 and 8) and new types of harp (nos 6 and 9), but no wind instruments appear.

The design on kudurru number 11 marks a new departure as it links music with a group of armed marching men. The fortified structure below them is also evocative in this context. Isolated musicians may have been soldiers, but there is no earlier surviving iconographic evidence linking music and warfare at an institutional level. However, in the first millennium, music and warfare, often in a victory context, became closely linked (nos 12, 19). Processions of musicians in martial contexts (prisoners on number 20), and in religious contexts (nos 16-18), are also popular and wind instruments appear in the form of double pipes, a horn and a flute, for the first time played together with other instruments. The depiction of musicians accompanying banquets was revived (nos 13-15) and, indeed, reached it apogee under Ashurbanipal (no. 21).

This marks the end of the present survey. Some three decades later the Assyrian Empire collapsed, and the succeeding Late Babylonian period provides no further iconographic evidence of musicians playing in concert.

Notes

1 I have excluded singers from my classification due to the difficulty in identifying them, since most possible singers have their mouths closed. However, in his paper in this volume, Bo Lawergren established convincing criteria for identifying singers, based on the way they stood and the position of their arms.

2 Delougaz and Kantor (1972): 14-33; *id.* (1997): 147-148, pls 45 N, 155 A; see also Spycket (1972): 158 and fig. 2

3 An animal skin? See Boehmer (1999), *Abb.* 24 k-s, 29 A-N, 33 a-b, 35 A-G, 48 from Uruk IV.

4 *cf.* Boehmer (1999), Abb. 24 n-r, pl. 77: No. 25A-C

5 The posture of the figures is found at Susa (Boehmer 1999, *Abb,* 102a, 103, 116b, 122d-h) and on some sealings on clay balls accompanying exports from Elam (south-western Iran) to Uruk (*op. cit. Abb.* 24 o-r with a similar vessel) and to Tell Sheikh Hassan in Syria (*op. cit. Abb.* 111a).

6 For harps see Bo Lawergren in this volume.

7 Woolley (1934), pls 71, 76 a-b. For work on the human remains preserved in the University Museum in Philadelphia, see Baadsgaard *et al.,* forthcoming. I am indebted to Theya Molleson for sharing her views with me and for providing me with this reference and a copy of the article.

8 Woolley (1934) pl. 111, U.12354.

9 Woolley (1934) pls 112-113 a, U.12356.

10 Woolley (1934) pls113 b-115; U.12353.

11 Woolley (1934) pl. 105; U.10556.

12 This is an Akkadian seal (c. 2250 B.C.) in the Louvre in Paris, Delaporte (1923) A.172, pl. 74:1. I have added it here after Uri Gabbay had drawn attention to it in his paper.

13 Legrain (1936) no. 384.

14 Woolley (1934) pl. 193: 21; U.11904.

15 Beyer (2007) no. 4: 237-40.

16 Beyer (2007): 254 figs 17-18; in each case it is held over the head of Ishqui-Mari, a late Early Dynastic ruler of Mari. This is, so far, the earliest depiction of a parasol as a symbol of royalty, and it was to retain this meaning into Assyrian and Achaemenid Persian times and beyond.

17 Collon (1987/2005) no. 666; Oguchi 2002: 43-4, pl. 5, C14; light brown stone; 2.5 x 1.6 cm.

18 See Bo Lowergren's paper in this volume.

19 Özgüç (1988) fig. 64.

20 Collon (1982) no. 47; Collon (1987/2005) no. 664.

21 Delaporte (1920) D. 56.

22 Seidl (1989) no. 40; 56 x 25 x 20 cm)

23 Çambel and Özyar (2003) pls 50-1, 144-5.

24 Barnett (1957/1975) S. 3: 91, pls XVI-XVII.

25 Mitchell, T. C. (1992): 126-127, discussed these instruments, that he calls Vibro-frames, with full bibliography. These were previously thought to be string instruments, but Mitchell reclassified them on the basis of examples found in excavations in Italy and from other known remains, for which he gives references. I am indebted to the author for sending me a copy of his article, and to Mr E. Li Castro for also sending me the reference to the Italian excavation report (Montuoro 1977, esp.: 27-40 and pls IX-XIV).

26 Çambel and Özyar (2003) pls 142-143, 206-207.

27 See Çambel and Özyar (2003) pl. 128.

28 Woolley (1969) pls B.17 b and 18 b.

29 Barnett *et al.,* (1998) nos 671-674.

30 Gadd (1936) pl. 25 and: 90-91; Barnett (1976) pl. XIV.

31 Parrot (1960): 310 fig. 391; Barnett (1976); 59-60 pl. LXVIII.

32 Barnett *et al.* (1998) nos 385-386.

33 Barnett (1976) pls LXIII, F.

34 Barnett (1976) pl. LXIV b, i) London, British Museum ME 124920, 124922, 135115-135117; Berlin VA 159 and 969; Or. Dr. V, 46, 42, 43, 45.

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Sources of the illustrations

Fig. 1. Author's drawing (from Delougaz and Kantor (1972)).
Fig. 2a-e. From Woolley (1934).
Fig. 3a. From Woolley (1934).
Fig. 3b. By Tessa Rickard, in Black and Green (1992), p. 25, fig.17 ; reproduced courtesy of the Trustees of the British Museum.
Fig. 4. From Collon (1987/2005), no. 669.
Fig. 5. Drawing by Margaret Jaques in Beyer (2007) p. 39, fig. 4c. Reproduced with Professor Beyer's kind permission.
Fig. 6. Author's drawing.
Fig. 7. From Rashid (1984) p. 77, *Abb.* 59.
Fig. 8. Adapted from Özgüç (1988) fig. 64.
Fig. 9. Author's drawing.
Fig. 10. From Delaporte (1920) D. 56.
Fig. 11a-b. Author's photographs.
Fig. 12. Author's photograph.
Fig. 13. Author's photograph.
Fig. 14. Drawing from Barnett (1957/1975) S. 3 pl. XVI.
Fig. 15. Author's photographs.
Fig. 16. Photomontage from Gadd (1936), pl. 25 and Barnett *et al.* (1998).
Fig. 17. Author's photograph.
Fig. 18. Author's photograph.
Fig. 19. From Barnett (1976).
Fig. 20. Author's photographs.
Fig. 21. Photomontage from Original Drawings, and photographs from author and Barnett (1976).

A QUEEN'S ORCHESTRA AT THE COURT OF MARI: NEW PERSPECTIVES ON THE ARCHAIC INSTRUMENTARIUM IN THE THIRD MILLENNIUM*

Myriam Marcetteau

Foreword

TH 97-35 was first published by Dominique Beyer who gave a preliminary analysis in : 'Les sceaux de Mari au IIIe millénaire': observations sur la documentation ancienne et les données nouvelles des Villes I et II, in *Akh Purattim I - Les Rives de l'Euphrate, Mémoires d'archéologie et d'histoires régionales interdisciplinaire*, sous la direction de Jean-Claude Margueron, Olivier Rouault et Pierre Lombard, Lyon, Maison de l'Orient et de la Méditerranée/Ministère des Affaires Etrangères, 2007, p. 237 ff.

The site of Mari has produced some 20,000 cuneiform texts dated to the early second millennium B.C. They were excavated during the past seven decades.[1] Among these, 400 related to the life of musicians and their practice of music.[2] There were twenty-five iconographic attestations of particular interest of which fourteen have been published.[3] Additionally there are ten terracottas currently being studied by Isabelle Weygand.

Unfortunately, most of this material was found out of context. However the musicological significance is such that it merits attention. Seal impression TH 97-35, dating to the middle of the third millennium B.C.[4] is of particular interest to musicology. Although well worn,[5] this predynastic bulla reveals an atypical depiction of an orchestra from a Queen's Court at Mari and offers significant clues for comparative organolo-philology inasmuch as it can help elucidate our understanding of the nomenclature of the ancient Mesopotamian instrumentarium.

Another grant from the Institut Français du Proche Orient enabled my research mission to Syria, generally, and particularly to the Museum at Dayr ez-Zawr where I took photographs of the clay *bulla* TH 97-35, the impressions of which being the object of the present paper.

Fig. 1. Seal impression TH 97-35.

An atypical musical scene

The scene is set in three registers.[6] The upper one has a symposium with five individuals. There is an inscription with the name of a queen. The two lower registers below show a group of eleven musicians of which two, perhaps three, dance and clap their hands.

The depiction is atypical in that the number of musicians is most unusual for the third and second millennia, when usually no more than three to five musicians are shown playing together.
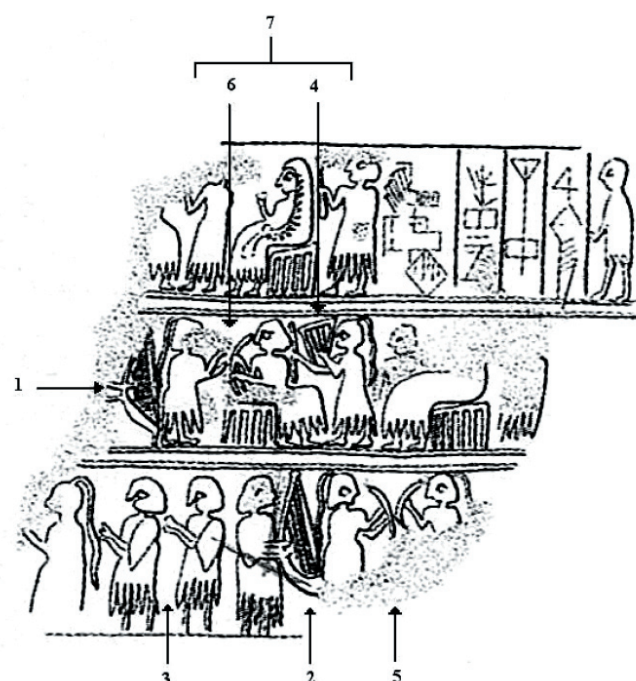

Fig. 2. Beyer's hand copy.

This might be the first occurrence of a heterogeneous ensemble with such a number of musicians. Parallels for it are unknown until the first millennium.[7]

The narrative scene includes at least eight instruments including two monumental arched harps, one small portable lyre and five sets of clappers.[8]

Another significant peculiarity of this ensemble is that it is made up exclusively of female players. Usually, women play solo whilst orchestral parties appear to be a male prerogative[9] (there do exist female duos but they appear very much later, during the Seleucid Period.[10])

Could this constitute a *šitrum*-orchestra?

Ziegler's recent work on music at Mari has prompted the hypothesis that this seal impression might fit the definition she gives of the *šitrum*-orchestra (*hapax legomenon* from Mari). She defines the substantive as an instrumental and/or vocal ensemble[11] composed of the *šitrêtum*[12] known as female musicians.[13]

Unfortunately, the poor condition of the impression does not allow us to see if the musicians are also singing.[14] Additionally, two, possibly three women, at the lower left of the register, are clapping their hands.[15] This suggests that they might also have danced along with the music. Therefore, it is very likely that dance was practiced by the *šitrum*-orchestra.

Fig. 3. Two or three females clapping their hands, possibly singing and dancing. Detail of figure 2 above.

Although this impression is the only occurrence of such an ensemble, it is contended that the seal, which belonged to a queen, depicted an orchestra which would have entertained at the harem. This is supported by evidence elsewhere in texts from Mari which mention hundreds of female musicians listed among the 'staff' of the harem.[16]

Therefore it is my opinion that male or female musicians of the *šitrum*-orchestra were professionals. Regarding clappers, it seems evident that they would have been mostly used to accompany dancing.

Polyphony: a very ancient concept

The seal might depict musicians in the course of performance. Harpists have their right hand to the strings whilst the lyre player, or lyrist, plucks the strings with her left hand. The other musicians either use clappers or clap their hands. Thus it would not be unreasonable to suggest, on the basis of this instrumental and vocal diversity, that they played solo and tutti, in various combinations that need to be investigated.[17]

That two types of chordophones and two types of idiophones are depicted playing simultaneously introduces the concept of polyphony not encountered before in the Western vocal tradition of the ninth century A.D.[18] Even the practice of polyphony in Greek and Roman music remains conjectural to this day.[19] However, a close examination of the impression under scrutiny suggests that the scene evoked more than simple heterophony as indeed there are four distinct timbres. There are two harps, perhaps each with a different span and timbre; a lyre; clappers and hand clapping, and probably singing. Now these instruments would not have played the same notes at the same time and therefore polyphony is axiomatic, even if it resulted in a relatively unsophisticated performance.

The concept of a standard pitch also necessarily results from the hypothesis above, as it is certain that tunable instruments such as harps and lyres would have had to be tuned to each other and equally, be in tune with the voices which they would have accompanied.

The portable lyre

The sound-box of the portable lyre is trapezoidal, and looks slightly asymmetric. The lyrist's left hand lies flat on the strings. The wear on the impression does not reveal any details of the bridge. An educated guess would number at least three strings.[20]

Fig. 4. Detail of a lyrist playing.

These strings would have produced primary intervals such as the fourth or the fifth. Moreover, they had to match the tuning of both harps. Dumbrill states that the presence of three strings on an instrument that was part of a trained orchestra would imply that the tuning would have responded to some standard pitch because it would have had to suit the tuning of the other instruments.

Therefore from the central string - the shortest, logically also the highest in pitch - the other strings would have been tuned a fifth or possibly a fourth up and down away from the central string. It is contenbded that they would not have been tuned a third or a second or a semi-tone away from the central string because these are intervals which appear as a consequence of the tuning with fifths and fourths but not intervals with which to start a tuning sequence, although thirds might have been used to generate tunings in which thirds would be Just. The text *Nabnitu* XXXII (UET VII, 126) clearly shows fifths and fourths rising and falling from the axis of symmetry *ḫanšu*.[21]

Small lyres are extremely rare at this period and thus might it not be unreasonable to assume that this instrument first appeared at Mari at that time. Typically, contemporaneous lyres are monumental and played with both hands. Smaller portable models have only been, until now, later occurrences. Additionally, it seems that TH 97-35 is the first attestation of an azoomorphic, probably frontal-asymmetric portable lyre, in the iconography of the ancient Near-East. As such, it survived up to the end of Greco-Roman antiquity, when it became highly fashionable. I would suggest that this portable lyre could be equated with the Akkadian *kinnārum* since it appears to match the definition found from textual evidence at Mari. Smaller types appear to stem from the earlier 'monumental' lyres for the practical reason that they are portable. Now, the instrument known as *kinnārum* does not appear as an archaic pictogram equation and is only known written phonetically as *ki-in-na-a-rum*. Also, the diffusion of the word *kinnārum* is well spread and always refers to the portable type. We have Ugaritic *knr* in an alphabetic list of gods;[22] *kinara* in syriac;[23] *lukikirtalla* in Hittite.[24] At *Alalakh* we have Hurrian *kinnaruḫli* , the lyrist;[25] *kinnor/kinnūr* in Phoenician[26] and old Aramaic[27], and in later Semitic dialects[28] (although, Michalovski's proposition in this volume must be taken in consideration). We have *kinnōr* in the Bible;[29] *kin(n)yra* in Greek.[30] We have the Semitic loanword *knynywrw* (=*knwrw*) in ancient Egyptian,[31] and related to it, the late Karnak rendition *gnyry* from the Ptolemaic period,[32] the Coptic *ginēra* and Sahidic *genēre*.[33]

The Bible also adds that the *kinnōr* was made of *almug*-wood,[34] probably sandal-wood, at the time of Solomon, in the early first millennium. This wood was imported from the Lebanon.

It is impossible to say which kind of wood was used for the portable lyre from Mari in the second half of the third millennium as the texts mention the wood [giš]*kinnārum*, without specifying the type of material. However, some cuneiform texts from Mari give additional information about the materials used. Firstly the wood was partially or totally covered with gold;[35] secondly [kuš]*šinuntum* (Mari), which was a special

type of leather, was used for making the sound-board,[36] and thirdly the *šimtum*-glue was used[37] suggesting that the hide was glued to the sound box, and perhaps also nailed to it.

As remarked above, the lyre represented on TH 97-35 might well be the first depiction of an azoomorphic portable frontal asymmetric lyre in the ancient Near East.[38] I would further argue that its metamorphosis, from the monumental boviform lyre to this lighter model, might be a third millennium innovation from Mari.

This hypothesis is supported by the fact that the earliest known evidence of the *kinnārum* appears in cuneiform texts from the reign of *Zimrī-Līm*.[39] In these texts and with the seal TH 97-35, the *kinnārum* is an instrument played by female musicians, exclusively. This shows that it must have been, initially, an instrument only played by the musicians of the royal harem, and exclusively devoted to its entertainment. The iconographical and philological evolution attests that it only became played by men from the Seleucid period onward, at contests and the like.

The identification and making of the monumental bowed harp

Kilmer states that the *sammūm*-instrument was the bull lyre because of its ressemblance to the archaic pictogram áb, which is trapezoidal, and the stylised shape of the bovid's nose.[40] However, Gurney, Dumbrill, Lawergren, Michalowski and others disagree and base their argument that the *sammūm* was a harp, from organological and other evidence based on theory.[41] I would agree that the monumental arched harps on the impression both represent a *sammūm*.

In figure 5 below, two musicians stand behind their instruments in identical positions. In both cases they hold onto one of the uprights with the left hand while the right hand plays the shortest strings. They do not seem to be using a plectrum.

Fig. 5. Details of the two monumental harps.

The fifth string appears twice as long as the first one, which means that the span was of one octave, should the strings be of equal mass and tension which is a reasonable assumption. It is possible that the tuning was pentatonic anhemitonic, with fifths or fourths within the span of one octave.[42]

One of the harps seen at the intermediate register has what looks like a foot. Its function might have been to set the height of the instrument according to the height of the player. The lowest part of the second harp is quite damaged, but is likely to have had a foot as well. Mesopotamian iconography shows such devices on harps as early as the middle of the third millennium B.C.,[43] and the musicians at Mari would have adopted this new technology as soon as it appeared in the south. Monumental arched harps might have been monoxylous instruments. In that case, the sound box and the yoke would have been made from the same component, but it was undoubtedly easier to build a large instrument from several different materials, as was the case, obviously, with later angular types.[44]

Attachment of the strings

The impression TH 97-35 is too small and far too worn to show how the strings were attached on both harps and lyres. Generally, iconography has revealed that the common practice with lyres was to wind the strings round the yoke on which a sleeve of rough leather or crude cloth had been glued or nailed. Then a tuning lever was insertetd through the winding. The tuning lever was pulled out to release the tension, the string was stretched to the desired pitch and then the tuning lever was pushed back in, to secure the tension. Tuning levers were not used on harps as far as we know. The strings were prolonged by a cord which was then pulled down to secure the tension. This was also used on lutes.[45] As both harps and lyre of TH 97-35 are archaic models, I would assume that this was the method which was used with them.

Clappers

Clappers are uncommon in Mesopotamian iconography. They are mostly played by men, more rarely by animals and are usually played in pairs by the same musician.[46] The scene depicted here is most unusual as it shows two female performers, the first holding only one clapper which she beats on her partner's clapper.[47] It is most unusual to find a group of five such idiophones, and even more so when they require five women to play them. On the lowest register two facing musicians are seen holding firmly onto theirs.

On the middle register, however, it seems that the sitting woman holds a pair of clappers in the traditional way. However, the upper part of the left clapper is far too worn out to allow for any conclusions about its shape.

Careful observation shows that, in fact, the woman

Fig. 6. Detail of a duo of clappers.

Fig. 7. Musician sitting.

only holds one of the two clappers whilst the second implement is grabbed by the woman standing to her left. A curved stick is held by the lyrist. Its shape is similar to the other four clappers, therefore this could be identified as such.

That the fifth clapper was the plectrum for the portable lyre has to be ruled out, especially because there is no other evidence of such in Mesopotamian iconography.[47] A single clapper has no purpose. The sitting woman might alternatively beat her clapper against the instrument held by her two partners, on each side of her, to her left and to her right. She sits in this position because this allows her to turn easily from one musician to the other.

Fig. 8. A trio of clappers.

Her waist is twisted in order to face the lyrist on her left. The scene might also suggest that some choreography could have been inspired from the usage of the clappers.

This seal constitutes the only example of an idiophonic trio in the Mesopotamian instrumentarium so far.

I expect my views will be challenged. However, the wear of the object could be the reason for a misreading of the narrative. But it must be said that the art of Mari is charaterized by its atypicalism as demonstrated by the famous statuettes of the nar-gal-chief singer Ur-nanše,[48] as well as this most unusual seal with three registers of which there is only one known parallel. Therefore, it would not be surprising if more unusual material from Mari turned up in the future.

Conclusion

The narrative in this scene challenges traditional theories of musicology and provides with crucial clues with regard the advancement of musical terminology. We have a large female musical group which fits with the definition of *šitrum*-orchestra. It is the largest and varied orchestra known prior to the 1st millennium B.C. There is evidence of polyphony. We probably have the first icnonographical occurrence of an azoomorphic portable lyre which appears to match with the word *kinnārum*. We have evidence of early technological innovations of the bowed monumental harps, such as the foot and the enlargement of the sound box. Lastly, there is an atypical usage of clappers. The protodynastic impression TH 97-35 is evidence of an original and a rich musical life at Mari during the second half of the third millennium B.C.

Notes

1 Transcriptions and translations of the tablets from Mari have mostly been published in the volumes of *Les Archives Royales de Mari. Transcriptions et Traductions* [=*ARM*] (1950-2005-Paris), Imprimerie Nationale/Librairie Orientaliste Paul Geuthner/Editions de Recherche sur les Civilisations; *Florilegium Marianum* [=*FM*] (1992-2007-Paris), Société pour l'Etude du Proche-Orient Ancien; Durand, J.M., *Les documents épistolaires du palais de Mari* [=*LAPO*] (1997-2000-Paris), Les Editions du Cerf, Littératures Anciennes du Proche-Orient; *Mari: Annales de Recherches Interdisciplinaires* [=*MARI*] (1983-1997-Paris), Editions de Recherche sur les Civilisations; Parrot, A., *Mission Archéologique de Mari* [=*MAM*] (1956-1967-Paris), Librairie Orientaliste Paul Geuthner, Collection de l'Institut de France d'Archéologie de Beyrouth.

2 Ziegler, N. (2007-Paris) FM IX, *Les Musiciens et la musique d'après les archives de Mari.* (1999-Paris) FM IV, Le harem de *Zimrī-Līm;* and Marcetteau, M., Doctoral thesis, forthcoming.

3 AO 17568, Parrot, A., *MAM IV*, no. 8: 104, fig. 66 and Les fouilles de Mari: première campagne (hiver 1933), *Syria, Revue d'Art Oriental et d'Archéologie* [=Syria] no. 16 (Paris, 1935): 117-140; Ziegler, N., FM IX: 264; Williamson, M. (1969) Les harpes sculptées du temple d'Ishtar à Mari, *Syria* no. 46: 209-224; Galpin, F. (1937-Cambridge) *The music of the Sumerians and their immediate Successors the Babylonians and Assyrians.* Cambridge: M 2416+M 2365, Parrot, A. (2006-Paris) *MAM* III: 89-96, 327-8; MAM IV: 89-91, 93, no. 68, figs 127-31, pls XLV-XLVI, Les fouilles de Mari-huitième campagne (automne 1952), *Syria* 1953 no. 30: 210, pl.XXIII; Sumer:

126-127; Ziegler, N., FM IX: 8, note 9. M 2272+M 2376+M 2384: Parrot, A., *MAM III*: 93-94, 328 *MAM IV*: 90, 92-93, no. 69, pl. XVIII, Les fouilles de Mari: huitième campagne (automne 1952), *Syria* (1953) no. 30: 209. M. 2459, Parrot, A., *MAM III*: 208-209, no. 251, and pl. XV. M.2791, Parrot, A., *MAM III*, pl. LXII; Margueron, J.C. (2004-Paris) *Mari, Métropole de l'Euphrate au troisième et au début du deuxième millénaire avant J.-C.*: 296. M 828; *MAM II/3*: 150 and pl. XXXIX. M 1022; *MAM II/3*, pl. XXIX; Badre, L. (1980-Paris) *Les Figures anthropomorphes en terre cuite à l'âge du bronze en Syrie*: no. 42 and pl. XXVIII. M. 2067; *op.cit.*, no. 43 and pl. XXVIII. M.990, Parrot, A., *MAM II/3*: 71, no. 56, and pl. XXIX; Badre, L., *op.cit.*, no. 57 and pl. XXIX. M 761, Parrot, A., *MAM II/3*: 71, no. 56, and pl. XXIX; Badre, L., *op.cit.*, no. 56 and pl. XXIX. AO. 21988, Parrot, A. (1983-Paris) *Au pays de Baal et d'Astarté, 10 000 ans d'art en Syrie*: no 146. M 1513/M 8012, Parrot, A., *MAM II/3*: 78, pl. XXXI and fig. 60. AO 19511, Parrot, A., *MAM II/3*: 79, pl. XXXI and fig. 60. TH 97-35. see note below.

4 Excavated by Margueron, J.C. (1997), *op.cit.*: 296. TH 97-36 (another bulla fragment) is yet unpublished, very similar to TH 97-35.

5 TH 97-35 is a damaged clay bulla around which the seal has been impressed several times. The drawing of the whole scene is a collation taken from each of the five impressions more or less visible on the bulla.

6 During ICONEA 2008, Piotr Michalowski drew my attention to this very atypical setting in three parts. Additionally, in a private communication, Dominique Collon informed me that cylinder seal designs in three registers are rare at all periods and often have purely geometric designs or patterns. For instance, of the 1002 cylinder seals from the Diyala, published by H. Frankfort in *OIP* 72 (1955), the majority are E.D., yet only three are in three registers (pls 35:357; 47:497 and 79:847), all are E.D. but none is a prestige seal [...]. There is one from the Ishtar temple at Mari (Parrot, *MAM I* (1956), pl. LXV: 329) which is unusually large and has a strange, but rather unsophisticated design. Some of the Archaic seal impressions from Ur have inscribed seals in several registers (Legrain, *UE III* (1936) pl. 24); the incomplete no. 533 in the same catalogue has two preserved registers with a double banquet scene, but no surviving inscription or musicians. The only three-register seals from the Royal Cemetery at Ur are patterns (Woolley, *UE II* (1934), pls 192: 2 of lapis and 202: 124), and seals of these types often have three registers; those of lapis were probably imported as beads from the East.

7 Rashid, S.A. (1984-Leipzig) Mesopotamien, in *Musikgeschichte in Bildern Band II*: 41, 65, no. 41-42; Hartmann, H. (1984-Frankfurt) *Die Musik der Sumerischen Kultur*: pl. XXXIII; Rimmer, J. (1969-London) *Ancient Musical Instruments of Western Asia in the Department of Western Asiatic Antiquities*: pl. VII: b.

8 For musical ensembles, see Rashid, S.A., *op.cit.*: 136-137; for four different instruments, *cf.* Rashid, S.A., *op.cit.*: 127, 135. See also Rimmer, J., *op.cit.*: pl. XI-XIII.

9 Females, Rashid, S.A., *op.cit.*: 97, 107, n°114-18, 141, 151; Rimmer, J., *op.cit.*: pls VI a, b, c, XXIV; Barrelet, M.T. (1968-Paris) *Figurines et reliefs en terre cuite de la Mésopotamie Antique*: pls.XXXIII – XXXVII, XLIII, XLVI; Karvonen-Kannas, K. (1995-Helsinki) *The Seleucid and Parthian Terracotta Figurines from Babylon*: pls 48-50. Males, Parrot, A. (2007-Paris) *Assur*: figs 60-61; Rashid, S.A., *op.cit.*: 56, 103, no. 107: 109, 115, 123, 127, 135; Rimmer, J., *op.cit.*: pls VII a and b ; Hartmann, H., *op.cit.*: pl. XXXIII.

10 Karvonen-Kannas, K., *op.cit.*: pls 55-56.

11 FM IX, § 1.2.1.1.1., p. 14. 'Il semble donc possible que le chant fût également pratiqué dans ces ensembles, car un "ensemble soubaréen" pourrait avoir chanté un répertoire de langue hourrite. Le *šitrum* serait alors à traduire par 'ensemble vocal et instrumental'.

12 For the word *šitrum*, *cf. op.cit.*: 13 and FM IV, 37, line 1.

13 Ziegler also points out that a male *šitrum* performing for the Eštar ritual, *FM IX*: 55-64 and 14, note 47. But this might be an exception. There is no mention of a mixed *šitrum* insofar, *op.cit.*: §1.3.1.1.

14 For some vocal *šitrum*-orchestras at Mari, see *FM III*: no. 143; LAPO 18: no. 1166.

15 The woman at the far left has the same position as her neighbours, but is not dressed the same way, which means she might be part of the dancers group or a clapper player.

16 *LAPO* 16, 262 (= *ARM XIII, 22*); LAPO 18, 1166 (= *ARM X, 126*), 1167 (= *ARM X: 125*); FM IV: 37; FM IX: 12 (= *LAPO 18: 1160; MARI 3*: 136; *ARM X: 137*), 41, 50.

17 There is at Mari an example of an orchestral *šitrum* alternating with a solo singer playing the instrument *ḫalḫallatum* for the Eštar ritual: *FM IX*: 55-64.

18 See Frobenius, W. (2001) 'Polyphony', in the *New Grove Dictionary of Music and Musicians*: 74: the first definition of polyphony 'multiplicity of parts' matches our purpose: 'an author [who] contrasted cantus simplex for one part with polyphonic for more than one part', but refers to a piece of work dating from ca. 1200, wrongly attributed to Johannes de Muris. Nevertheless, musicologist Chailley felt as early as 1967 that the musical Christian treatises of the 9th century dealing with rudimentary polyphonic settings (responsorial/antiphonic and paraphonic singing), are the beginnings of the written traditions of music, but not obviously the beginning of polyphony, Chailley, J. (1967-Paris) *Cours d'Histoire de la Musique. Tome I – des origines à la fin du 17ème siècle* 'Naissance de la polyphonie primitive': 43. However, despite this relevant assessment, the lesson begins with the parallel writing of the Primitive Church music (the *Enchirias musices* by Oger and the Anglo-Saxon gymel). See also Schaeffner, A. (1968-Paris) *Origine des instruments de musique, Introduction Ethnologique à l'Histoire de la Musique*: 'Polyphonie primitive': 312-331, and the *Reallexicon der Assyriologie und Vorderasiatischen* Archäologie (1983-Berlin-Leipzig) [=*Reallexicon*]. 'Musik', §7 : Monody versus Polyphony: 480.

19 Is an octave a polyphonic interval or the duplication of an already existing note? Another question was how to determine instrumental timbres and registers were mixed, with or without any connotations of musical technique? Neither was this clear with ancient Greek theoreticians. Plato and Ptolemy, even though they disagree in understanding of the octave, raised the question of the concept of polyphony, monophony, heterophony, paraphony, and antiphony, Plato, *Laws*, 812d ; Ptolemy, *Harmonics*, especially Book II.

20 The number of three strings is atypical for the third millennium/ early second millennium B.C. Generally, archaic lyres show up to eleven, see Rimmer, J., *op.cit.*, frontispiece and pl. XI; Rashid, S.A., *Musikgeschichte op.cit.*: 35, 41, 45, 67, no. 45).

21 Transcription and translation of UET VII 126 (Kilmer, A. (1984) 'A Music Tablet from Sippar (?): BM 65217 + 66616', *Iraq* 46: 70.)

Sumerian	Akkadian
1 sa.di	*qud-mu-u[m]*
2 sa.uš⁴	*šá-mu-šu-um*
3 sa.3.sa.sig	*šá-al-šu qa-a[t-nu]*
4 sa.4.tur	*a-ba-nu-[ú]*
5 sa.di.*5	*ḫa-am-[šu]*
6 sa.4.a.ga.gul	*ri-bi úḫ-ri-im*
7 sa.3.a.ga.gul	*šal-ši úḫ-ri-im*
8 sa.2.a.ga.gul	*ši-ni úḫ-ri-im*
9 [sa.1].a.ga.gul	*úḫ-ru-um*
10 [9].sa.a	*9 pi-it-nu*

Sumerian	Akkadian
l.1 String-first	front/fore (string)
l.2 String-second	second
l.3 String-three-string-thin	third, thin
l.4 String-four-small	Ea-creator
l.5 String-five	fifth
l.6 String-four of the behind	fourth behind
l.7 String-three of the behind	thrird behind
l.8 String-two of the behind	second behind
l.9 [String-one] of the behind	one behind
l.10 [Nine] string	nine strings

22 dingir ᵍⁱˢ*ki-na-rum* = *knr. cf.* Dahood, M. (1965-Rome) Hebrew-Ugaritic Lexicography III, *Biblica* n°46: 329; see also *Reallexicon, sub* 'leier', §3: 573.

23 Payne-Smith, J. (1903-Oxford) A *Compendious Syriac Dictionary*: 202.

24 Keilschrifttext aus Orient-Boghazköy in *Wissenschaftliche Veroffentlichung der deutchen Gesellschaft* (1916-Leipzig-Berlin). I, 52, I, 15 f.; see also Friedrich, J. (1952-1954-Heidleberg) *Hethitisches Wörtbuch*: 110 a.

25 Soden, W., von (1972-Wiesbaden) *Akkadisches Handwortebuch* [=*Ahw*] II: 1568.

26 Harris, Z.S. (1936-New Haven) A Grammar of the Phoenician Language, *American Oriental Series* [=*AOS*]: 112. see also Hoftijzer, J. (1995-Leiden) *Dictionary of the North-West Semitic Inscriptions*. Part I: 520.

27 Donner, H., and Rolling, W. (1966-Wiesbaden) *Kanaänaiche und aramäische Inschriften*: 222 A, 19.

28 Koehler, L., and Baumgartner, W. (1967-Leiden) *Lexicon in Veteris Testamenti Libros* [=*KBL*]: 484.

29 Genesis iv: 21, xxxi: 27; Samuel I x: 5, xvi: 16 and 23; Samuel II vi: 5; I Kings x: 12; Isaiah v: 12, xvi: 11, xxiii: 16, xxiv: 8, xxx: 32; Ezekiel xxvi: 13; Psalms xxxiii: 2; xliii: 4, xlix: 5, lvii: 9, xcii: 3, xcviii: 5, cviii: 2, cxxxvii: 2, cxlvii: 7, cl: 3; Job xxi: 12, xxx: 31; Nehemiah xii: 27; Chronicles I xiii: 8, xv: 16, 21 and 28, xvi: 5, xxv: 1, 3 and 6; Chronicles II v: 12, ix: 11, xx: 28, xxix: 25.

30 Lewy, H. (1970-Berlin/New-York) *Die semitischen Fremdworter im Griechischen*: 164; Mayer, M. L. (1960)'Gli imprestiti Semitici in Greco', *Rendiconti del Instituto Lombardo di scienze e lettere Milano* no. 94: 328; Koehler and Baumgartner, W. : 457KBL: 484; Boisacq, E. (1923-Heidelberg/Paris) *Dictionnaire étymologique de la langue Grecque étudiée dans ses rapports avec les autres langues indo-européennes..*

31 Albright, W.F. (1934) The Vocalization of the Egyptian Syllabic Orthography, *AOS* no. 5: 47, C6; Helck, W. (1971) *Die Beziehungen Agyptens zu Vorderasien im 3 und 2. Jahrtausend v. Chr.* AgAbh, 5: 523, no. 253, and 129, 274, 540-2; Erman A., and Grapow, H. (1963) Wortbuche der ägyptishcen Sprache [*WbÄS*]. Leipzig. V, 132, iv. See also the papyrus Anastasi IV, 12.2. in Burchardt, M. (1910) *Die altkanaanäischen Fremdworte und Eigennamen in ägyptischen II:* no. 990.

32 Osing, J. (1976(?)) *Die Nominalbildung des ägyptischen*: 462.

33 Albright, W.F., *op.cit.*: 17 and footnote no. 72; J. Osing, *op.cit.*: 462; Westendorf, W. (1977) *Koptisches Handwortbuche*. Heidelberg: 459.

34 I Kings x, 11-12.

35 *ARM XXV*:547.

36 *ARM XXIII*: 213.

37 *ARM XXIII*: 180.

38 The grafitto from Megiddo, dating from the late fourth millennium B.C. (Israel Museum, IAA 38.954) shows an individual holding a string instrument that I identify as a frame harp with a forepillar, considering the period (the lyre, in structure more complex, came after the harp). Dumbrill says that the identification can only come from the way the strings are fixed to the soundbox: if they pull the soundboard out, it is typical of the harp; unlike it, the lyre strings push the soundboard in. But as the strings are attached to the back of the soundbox, it is impossible to determine the direction of pressure.

39 The first evidence was with Bottéro, J., in *ARM XIII:* 20 (= *FM IX: 11*;LAPO 16: 121). See also *FM IV*: 42, lines 4-5, dating from the year ZL 6'.

40 Kilmer, A. (1960) Two New Lists of Key Numbers for Mathematical Operations, *Orientalia* no. 29: 273-308, and consequently, *Reallexicon*, *sub* 'Leier': 573, Musik: 463, and Krispjin, T. (1980) Beitrage zur altorientalische Musikforschung, *Akkadica* no. 70: 6 and 23, note 39.

41 The 'overture' of the *sammūm* = geš-tu-za-mi (which makes no sense for a lyre as there is no opening in its structure), the gold fixtures of the *sammūm* seem to be the gold pegs of the Pu-abi's harp, etc. *Cf.* Gurney, O.R., and Lawergren, B. (1987) Sounds Holes and Geomerical Figures: clues to the terminology of ancient Mesopotamian harps, *Iraq* no. 49: 37-52, and Dumbrill, R. (2005) *The Archaeomusicology of the Ancient Near East.* Trafford. Book 3: 184, 222.

42 This setting fits the theoretical indications of UET VII, 74 for the giš zà.mí = *sammūm*: the indications are given according to a cyclical system of descending fourth (5-2, 1-5, 4-1, 7-4, 3-7, 6-3, 2-6). See Gurney, O.R. (1968) An Old Babylonian treatise on the tuning of the Harp, *Iraq* no. 30: 229-233, and Babylonian Music Again (1994) *Iraq* no. 56: 101-106.

43 Rashid, S.A., *op.cit.*: 53, no. 29.

44 The Ur texts attest that stringed instruments were made from various metals and wood essences (bronze, gold and silver for the soundbox: *sakkullu*-wood, cypress wood, and ma + gunu = pomegranate), Legrain, L., Business documents of the third Dynasty of Ur, *Ur Excavations Texts III* (1974-London): no. 363, 406, 423, 455, 547, 552, 554, 577, 578, 650, 680, 723, 1498.

45 Rashid, S.A. *op.cit.*: 35, 41, 81, 87, 89, 123, n°141, 139.

46 Rashid, S.A. *op.cit.:* 49 : no. 15, 16, 53: no. 30.

47 Barrelet, M.T. *op.cit.*: no. 829. Both Barrelet and Ziegler (*FM IX:* 262-3) identify these objects as weapons.

47a However, Collon, in the present volume: 60, fig. 13a, disagrees with me since she interprets a plectrum when I see a thumb.

48 Parrot, A., *MAM III*: 89-96, 327-8; *MAM IV*: 89-91, 93, no. 68, figs 127 to 131, pl. XLV et XLVI; Les fouilles de Mari-8ème campagne (automne 1952), *Syria* 1953 no. 30: 210, pl. XXIII; *Sumer* 2006: 126-127; *FM IX:* 8, fn. 9. For the ambiguous gender of Ur-nanše, see Spycket, A. (1972) La musique instrumentale mésopotamienne, *Journal des Savants.* Institut de France: 156.

49 Collon, D., *First impressions*: p. 101, no. 453; p. 124, 525.

Appendix

By: Richard Dumbrill

The bulla from Mari with seal impressions (TH 97-35), the object of Marcetteau's paper, and the remarks made upon its delivery during the ICONEA 2008 conference, have prompted the present analysis of third millennium glyptic reliability. An objection about one of Marcetteau's postulations was that in the piece under discussion, with regard to the two harps depicted, there could be no reliable metrology drawn from them. This appendix will expose that, contrarily to this objection, the care of the lapicide was such that their anaglyphs can provide us with reliable organo-metrologic data.

Methodology

The method for this study consisted in tracing the stringing plan for both harps. This was taken from an average outline with little error tolerance. The angle of the plan was made from the lines taken from first and last strings at both their extremities. The material arising from the outline was used for comparative analysis of string lengths and angles produced, with sexagesimal string lengths quantification as we know it from the tables of regular numbers in the mathematical texts excavated at the Temple Library of Nippur, ca.2200 B.C. The figures are given as regular numbers, in string-length as well as in frequency ratios and in musical cents.

Fig. 1. These enlargements have been lifted from the photographs taken in situ by Marcetteau. The positioning of the instruments has been modified so that the verticals of the instruments form a 90⁰ angle with the horizon line, for better evaluation.

Analysis

Firstly, let us examine the morphology of the harps. They belong to the arched monumental monostructural type which had elsewhere been wrongly defined as monoxylous as it is impossible to ascertain if the body of the instruments were made of the same wood throughout and exclusively. It is equally impossible to determine, specifically, any other medium that would have been used for their making. The choice of materials is fairly varied. Hollowed-out wood is a possibility, but they could also have been made of mould-shaped and sun-dried raw hide; of woven vegetal, or mixed vegetal and animal fibres, bonded with bitumen, polished, painted, or otherwise treated to satisfaction. They could also have been gold-, silver-, or copper-plated. Philology provides additional clues. However, this is not relevant to this appendix which is exclusively tonometric.

Now, the argument against the possibility of meaningful organo-metrology rests on the fact that at

prima facie, res ipsa loquitur: it is far too small to produce anything reliable. However, my counter-argument is that unreliability is unproven as long as it remains untested and that therefore the following analysis consists in proving that, at least in the case of TH 97-35, the lapicide's accuracy was metrologically reliable.

The outline of the internal angles of the body of the harps have been drawn from an average calculation and produce 111° for harp I and 107° for harp II. This produces a comfortable average of 110° degrees.
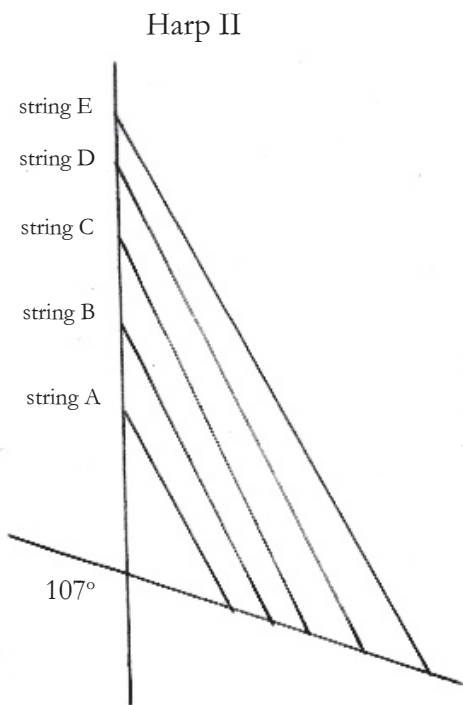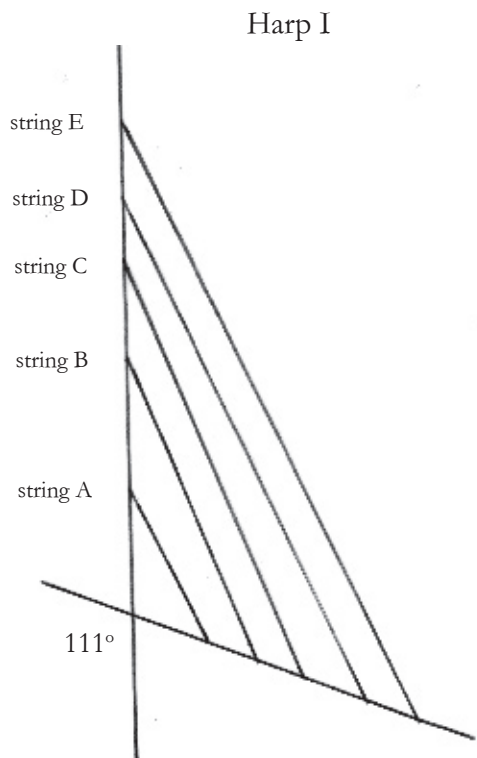
The length of the strings are averaged and the figures reduced to fit within the regular numbers up to 80. With both harps, string A is the shortest.

The tables that follow list the five strings, A;B;C;D;E, the column headed 1/1 gives measurements from the photographs; 1/2 is the division of the figures to fit in with the Nippur numbers; the column headed Nippur gives the corrections of the readings to fit with the sexagesimal paradigm. Therefore the tolerance percentage is within the difference between the readings of column 1/2 and column Nippur.
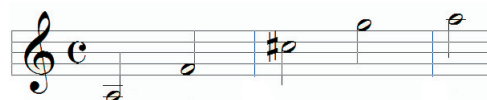
Harp I

String	1/1	1/2	Nippur	Note
A	40	20	20	A
B	75	37	36	G
C	104	52	50	C#
D	126	63	64	F
E	153	76	80	A

Harp II

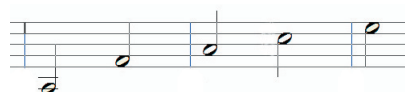| String	1/1	1/2	Nippur	Note
A	42	21	20	A
B	64	32	32	F
C	85	42	40	A
D	104	52	50	C#
E	124	62	60	E

Harp I

Harp II
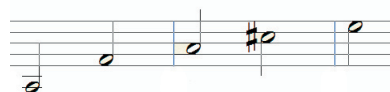
The presence of C# is incongruous and I would restore it with a natural C which in the Nippur tables is 48 instead of 50. This constitutes a negligeable quantity. This gives:

Harp I

Fig. 2. Outlines of harps I and II showing an average angle of 110°.

Harp II

Therefore, the correction must be applied to tables for harps I and II in order to define relative pitches and cent values for each of the strings.

Harp I redefined

String	1/1	1/2	Nippur	Note
A	40	20	20	A
B	75	37	36	G
C	104	50	48	C
D	126	63	64	F
E	153	76	80	A

Harp II redefined

String	1/1	1/2	Nippur	Note
A	42	21	20	A
B	64	32	32	F
C	85	42	40	A
D	104	50	48	C
E	124	62	60	E

Harp I has the following ratios: 80:64; 64:48; 48:36; and 36:20

80:64 = 386.31 cents = just major third

64:48 = 498.05 cents = just fourth

48:36 = 498.05 cents = just fourth

36:20 = 1017.60 cents = acute minor seventh

Harp II has 60:48; 48:40; 40:32; and 32:20.

60:48 = 386.31cents = just major third

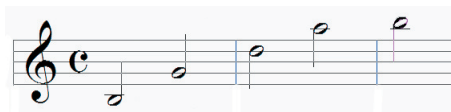48:40 = 315.64 cents = just minor third

40:32 = 386.31 cents = just major third

32:20 = 813.69 cents = just minor sixth

All of these intervals are just because they come from the sexagesimal Sumerian system. They fit in with the earliest Mesopotamia theory which found its roots in the Sumerian model. For instance, with harp one, we have:


Which can be transposed as:

Note that now the central note is a D from which an ascending and a descending fifth are projected forming the enneachord we find with UET VII, 126.

Note that the extreme notes are distant from their neighbours by a minor sixth. The span of this instrument is the double octave.

If an identical transposition is made with harp II, we have the following:
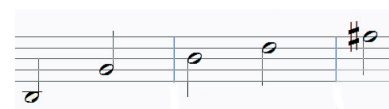
Here the span is smaller. However, both start from the bass with a just minor sixth. The central D is surrounded by a descending just major third and an ascending just minor third, the central D is a just fifth away from top f#.

We could derive that the central D, in both harps, equates to *ḫanšu* as we have it in *nabnitu* XXXII and other texts.

Should the present experimentation in organo-tonometry be correct, then this would prove that the theory in Nabnitu XXXII was known in the second half of the third millennium, at Mari, if not elesewhere in Mesopotamia.

These monumental angular monostructural harps were the equivalent of our double bass and would have had their strings played in pre-defined repetitive patterns for which we have good paralels in *Gnawa* music in the south of Morocco, although this would be played on the monumental *genbri*. The absence of semitones could be construed as evidence that these instruments were conceived to play in the pentatonic *genus*.

Testing the results

However satisfactory these figures may be, it still remains to be proved that variations in the angle of the harps would not yield equally satisfactory figures. The results have shown that only a right-angled instrument gave measurements which were even more satisfactory than those produced with the original 110 degrees, but this gave a diatonic system, and the harps from Mari were certainly not tuned diatonically at that time, as we have seen, above. They were pentatonic paradigms. Harp I has 60;50;40;30 and 15 and harp II has 50;40;36;25 and 15. However, other test measurements with 45°, 135° and one other aleatory figure gave measurements of little coherence. Therefore it is reasonably safe to rely on the accuracy of the lapicide.

However, the next problem concerns the technique that was used to reach such accurate levels and for which I am unable to give any satisfactory answer. Would seal makers be given instructions that were so precise that the angles of harps and the number and position of their strings be sufficiently reliable to allow us, millennia later, some serious organo-metrology?

ANCIENT NEAR EASTERN AND EARLY JEWISH LYRE TRADITIONS

Siam Bhayro

In a previous paper, I discussed David's use of the lyre to calm King Saul's bouts of mental illness, and how the Biblical narrative fits in with ancient near eastern traditions relating to the lyre.[1] The conclusions reached were as follows:

1 – The lyre originated in the Levant, from where it was exported to Greece, Mesopotamia and Egypt. Certain traditions associated with the lyre accompanied it on its travels, manifesting in each of the three cultural spheres to which it was exported as well as in its original Levantine setting. Thus, in all four regions, we can discern that the following beliefs were held: the lyre is divine in origin and/or nature; its sound is either from the spirit realm or is the voice of a god; it is the instrument favoured by the gods; and, finally, its use has a special significance in a cultic context.

2 – The phrase 'a man who knows, a lyre-player' (1 Sam.16:16) is a technical term for one who is able to communicate with the spirit realm and has strong mantic and shamanistic associations. Thus David's introduction into Israelite court life reflects that of Joseph in Egypt and Daniel in Babylon, both of whom enter court life in the guise of a mantic wise man.

Both of these points require further comment, and so I am grateful for this opportunity to present more evidence relating to the lyre in antiquity. Before discussing the lyre's association with mantic wisdom, I would like to discuss one tradition associated with the lyre that I neglected in my last paper, that of its association with militaristic endeavours.

The Lyre at War

The association of the lyre with a military hero is not unique to David. We also see this with Alexander the Great, who, it is said, learnt how to play the lyre from his tutor Lysimachus.[2]

We are concerned here, however, with the broader use of the lyre as an instrument of warfare to whose sound armies would march and charge into battle. We are already accustomed to the military use of trumpets and percussion instruments,[3] but such a use of the lyre is surprising, not least because it seems so unsuitable for this purpose.

In view of this, it is not surprising that the following verse from the book of Isaiah has come under intense scrutiny. The context is a prediction of the destruction of Assyria, who has served its purpose as the rod wielded by God (Isa.10:5 & 30:31) and is now, ironically, to receive the blows of another rod:

Isaiah 30:32

והיה כל מעבר מטה מוסדה
אשר יניח י׳ עליו
בתפים ובכנרות
ובמלחמות תנופה נלחם בה:

And every blow of the rod of appointment,[4]
which the LORD shall lay upon him,
with drums and with lyres,
and with weapons of elevation[5]
  he shall wage war against him.[6]

It is not necessary, however, to discount the military use of the lyre. As we have seen (notes 4-6), the textual challenges in this verse are not beyond solution. Furthermore, there is external evidence to support the military use of the lyre. Thus Pausanias, writing in the 2nd century C.E.,[7] states:

Description of Greece, Book III, xvii 5

Ἐν ἀριστερᾷ δὲ τῆς Χαλκιοίκου Μουσῶν ἱδρύσαντο ἱερόν, ὅτι οἱ Λακεδαιμόνιοι τὰς ἐξόδους ἐπὶ τὰς μάχας οὐ μετὰ σαλπίγγων ἐποιοῦντο ἀλλὰ πρός τε αὐλῶν μέλη καὶ ὑπὸ λύρας καὶ κιθάρας κρούσμασιν.[8]

On the left of 'She who dwells in a bronze house',[9] they established a sanctuary of the Muses, because the Lacedaemonians used to go out to fight, not with trumpets, but to the music of flutes and to the striking of the lyre and kithara.

The association between the Muses and the lyre was very strong in the Classical world,[10] hence Pausanias' explanation for the sanctuary of the Muses being placed next to the shrine for Athena, goddess of war. Thus, according to Pausanias, the Spartans would march out to the melody of flutes, accompanied by a rhythm section consisting of two types of lyre. The use of κρούσμασιν < κροῦμα 'beat, stroke' strongly suggests that the lyres were being strummed to give a rhythmic as well as tonal background to the melody of the flutes. This observation has repercussions for the continuing debate over whether the Sumerian term balaĝ refers to a

lyre or some kind of drum.[11] As Pausanias demonstrates, the use of an instrument for rhythmic purposes does not preclude its being a stringed instrument.

It is possible that the same occurred in ancient Egypt, where such rhythmic needs, in both peaceful and military contexts, were fulfilled by bands of singers. Thus, for example, singers were used to set the rhythm for quarry work and stone hauling, and military singers participated in New Kingdom Theban processions. There are rock inscriptions that show a musician playing the lyre with his head tilted back and mouth open, indicating singing, which could suggest that military singers were simultaneously playing the lyre.[12]

The idea that singers were accompanying stringed instruments in military processions is supported by Assyrian texts that refer to public processions following successful military campaigns. Thus, for example, Langdon states that 'returning from a victorious invasion of the Mediterranean sea-board Asarhaddon entered the public square of Nineveh to the music of the private psalmists who played upon harps' and 'Asurbanipal likewise entered Nineveh from the Elamite wars to the music of the "private psalmists who make a joyful noise"'.[13]

It is possible, therefore, that both Egypt and Mesopotamia furnish evidence of the use of musicians in a military context, simultaneously playing the lyre or harp and singing, although the scarcity of evidence means that this can only remain a suggestion at present. The pairing of singing with lyre playing, however, is very important, and we shall return to it in due course.

An acceptance of the military use of the lyre is certainly discernable in the Dead Sea Scrolls. A Qumran *pesher* [14] on Isa.30:32, although fragmentary, certainly suggests this. The original editor identified the main body of text on the fragment of interest as Isa.31:1 with commentary. He also noted that this is preceded by traces of Isa.30:32, again with commentary, albeit in a very damaged state:

4Qpap pIsaᶜ (4Q163) 25:2-3

בתופים ובכנו[רות]...כלי מלחמה...

… with tambourines and with ly[res] … *vessels* of war…[15]

The restoration of ובכנורות is unanimously accepted as it is probably a quote from Isa. 30:32 (discussed above). The interesting element here is the addition, probably as part of the commentary, of the phrase כלי מלחמה '*vessels*, of war'. The term כלי 'vessels' however, is wonderfully ambiguous, with 'utensils' (*e.g.* Num. 3:36), 'weapons' (*e.g.* Eze. 9:1) or 'musical instruments' (*e.g.* Ps. 71:22) all possible meanings.[16] But כלי מלחמה, for example was translated as 'weapons of war' by Allegro.[17] Horgan gave 'instruments of battle'.[18] García Martínez and Tigchelaar gave 'implements of war'.[19]

If the addition of the term כלי מלחמה 'vessels, of war' is meant as an explicative or elaborative gloss on what precedes it (*i.e.*, the tambourines and lyres), then we are left to ponder whether the term was meant to convey the idea of musical instruments or weapons. Perhaps it was chosen precisely because of this ambiguity, so that it would convey both meanings. But, whichever connotation was intended, the militaristic association of these instruments is certainly implied.

Whilst 4Qpap pIsaᶜ may be a fragmentary piece of evidence, our next example is much clearer. It is not particularly surprising to find a reference to the lyre in the collection of sectarian Thanksgiving Hymns from Cave One of Qumran, as the Biblical book of Psalms has several such references (*e.g.* Ps. 33:2, 43:4, 49:5, 57:9, 71:22, 81:3, 92:4, 98:5, 108:3, 137:2, 147:7, 149:3, 150:3). What is surprising, however, is the context, which has nothing to do with its use as an instrument of praise:

1QHodayotᵃ (1QHᵃ) 13:29-30

וישיגוני במצרים לאין מנוס...

ויהמו בכנור ריבי ובנגינות יחד תלונתם עם שאה ומשואה

And they came upon me in narrow places,
    without escape…
And they rage with the lyre,
    my strife together with the music of stringed
    instruments, their growls are with destruction and
    devastation.[20]

In this passage, therefore, the attack on the sectarian psalmist is accompanied by the music of stringed instruments, specifically the lyre. The verb נשג 'to come upon' is used in a militaristic or violent sense several times in the Bible (*e.g.* Exod. 15:9; Deut. 19:6; 2 Kgs 25:5; Jer. 39:5, 42:16, 52:8; Hos. 10:9; Ps. 7:6, 18:38; 1 Chr. 21:12),[21] and this is its most likely meaning in this context. Furthermore, the verb המה 'to rage' can be used of those intent on violence (*e.g.* Isa. 17:12; Jer. 6:23, 50:42, 51:55; Ps. 83:3).[22]

From both 4Qpap pIsaᶜ and 1QHodayotᵃ, it seems that the connection between warfare and the use of the lyre, suggested by Isa. 30:32, persisted into early Judaism. Furthermore, as we have seen, there is external evidence for this connection, certainly in ancient Sparta, and possibly also in Egypt.

The Lyre-player as a Wise Man

In my previous paper,[23] I established the mantic context of the use of music in therapy, specifically for mental illness, with reference to ancient near eastern traditions in general and the Biblical narrative of Saul and David in particular. I also noted that this theme recurs in subsequent early-Jewish corpora, but I left my analysis of these occurrences for a later date. We shall now return to this, paying attention to wisdom traditions that are associated with the lyre player.

The Psalms Scroll, from Cave Eleven of Qumran, provides an interesting note on the compositions of David. Underlying this note is an exegesis of the David narrative that emphasises his scribal and mantic characteristics:

11QPsᵃ (11Q5) 27:2-11

ויהי דויד בן ישי חכם ואור כאור השמש וסופר
ונבון ותמים בכול דרכיו לפני אל ואנשים ויתן
לו יהוה רוח נבונה ואורה ויכתוב תהלים
שלושת אלפים ושש מאות ושיר לשורר לפני המזבח על עולת
התמיד לכול יום ויום לכול ימי השנה ארבעה וששים ושלוש
מאות ולקורבן השבתות שנים וחמשים שיר ולקורבן ראשי
החדשים ולכול ימי המועדות ולים הכפורים שלושים שיר
ויהי כול השיר אשר דבר ששה וארבעים וארבע מאות ושיר
לנגן על הפגועים ארבעה ויהי הכול ארבעת אלפים וחמשים
כול אלה דבר בנבואה אשר נתן לו מלפני העליון

And David, son of Jesse, was a wise man, a light as the light of the sun, and a scribe, one with understanding, and perfect in all his ways before God and men. For the LORD gave him an understanding and enlightened spirit, so that he wrote:

> 3,600 psalms;
> a song to sing before the altar concerning the continual burnt offering for each and every day of the year – 364;
> a song for the Sabbath offerings – 52;
> a song for the New Moon offerings and for all the days of the Feasts and for the Day of Atonement – 30;

And the (sum of) every song that he spoke was 446.

> Also, a song to play over the stricken ones – 4.

So the total was 4,050.

All these he spoke through prophecy, which was given to him from before the Most High.[24]

The writer begins by ascribing to David the status of חכם 'wise man' and סופר 'scribe'. Each of these terms is followed by a brief explanatory clause that contains a Biblical idea pertaining to scribal wisdom:[25] thus, for חכם 'wise man', we have the theme of אור 'light' and, for סופר 'scribe', we have the theme of נבון 'understanding' (compare, for example, Dan. 2:21-22). According to the writer, therefore, it is on account of David's status as a wise man and scribe that he possessed a רוח נבונה ואורה 'an understanding and enlightened spirit' that enabled him, בנבואה 'through prophecy', to compose the enumerated psalms and songs.

For the most part, the list of types of song contains no surprises as it refers to various cultic occasions. It seems that Biblical references to David appointing cultic musicians (*e.g.* 1 Chr. 16) inspired later traditions such as this. Another example is the following account from Josephus:

Antiquities, Book VII, xii 3 (§305)

Ἀπηλλαγμένος δ' ἤδη πολέμων ὁ Δαυίδης καὶ κινδύνων καὶ βαθείας ἀπολαύων τὸ λοιπὸν εἰρήνης, ᾠδὰς εἰς τὸν θεὸν καὶ ὕμνους συνετάξατο μέτρου ποικίλου· τοὺς μὲν γὰρ τριμέτρους, τοὺς δὲ πενταμέτρους ἐποίησεν. ὄργανά τε κατασκευάσας ἐδίδαξε πρὸς αὐτὰ τοὺς Ληουίτας ὑμνεῖν τὸν θεὸν κατά τε τὴν τῶν καλουμένων σαββάτων ἡμέραν καὶ κατὰ τὰς ἄλλας ἑορτάς.

David, being now free from wars and dangers, and enjoying profound peace from this time on, composed songs and hymns to God in varied meters – some he made in trimeters and others in pentameters. He also made musical instruments and instructed the Levites how to use them in praising God on the so-called Sabbath day and on the other festivals.[26]

Thus Josephus agrees with 11QPsᵃ, both in his statement that David composed songs and hymns and in the mentioning of Sabbaths and Feasts. This allows for the intriguing possibility that Josephus was aware of the contents of 11QPsᵃ.[27] In addition to supplementing the Qumran traditions with more detail about the music,[28] Josephus also explicitly states something only implied in 11QPsᵃ, namely that David made musical instruments and taught the Levites how to use them in a cultic context. This element of instruction suggests yet again that David had assumed the status of a wise man.

In this context, the reference to prophecy in 11QPsᵃ 27:11 is understandable.[29] What is surprising, however, is the reference to שיר לנגן על הפגועים 'a song to play over the stricken ones'. As Sanders noted, this refers to a song played for one who is tormented by an evil spirit.[30] As such, this phrase is building on the narrative of Saul's torment and David's use of the lyre to calm the evil spirit that caused it. According to this line of exegesis, David's use of the lyre in this specific case was indicative of his status as a wise man and scribe. Thus David not only gave therapy to Saul, but he also composed songs for others to use for the same purpose.

The statement adds another element to the Biblical account. According to 1 Sam.16, it was explicitly the playing on the lyre that calmed Saul's bouts of mental torment. Yet, according to 11QPsᵃ, as the phrase שיר לנגן 'a song to play' makes clear, it was a combination of singing and playing that countered the evil spirit. A midrash on Psalm 24 sheds some light on this. Having noted that the introduction to Psalm 23 (מזמור לדוד 'A Psalm of David') differs from that of Psalm 24 (לדוד מזמור 'Of David, a Psalm'), the question of how to understand the difference in word order is addressed in a way that exploits the semantic range of the preposition ל:[31]

Midrash Tehillim 24

כשהיה מבקש שתשרה עליו רוח הקדש
היה תובעה מזמור לדוד
וכשהיתה באה מעצמה לדוד מזמור...
וכל מקום שנאמר מזמור לדוד היה מנגן
ואח״כ היתה שורה עליו רוח הקדש
לדוד מזמור היתה שורה עליו רוח הקדש
ואח״כ היה מנגן...[32]

…When he was seeking that the Holy Spirit would rest upon him, he was summoning it (with the words) 'A Psalm of David'. But when (the Holy Spirit) came of its own accord, (he would say) 'To David, a Psalm'… And every place that 'A Psalm of David' is said, (it means that) he was playing, and after that the Holy Spirit was resting upon him. (But where it is said) 'To David, a Psalm', (it means that) the Holy Spirit was resting upon him, and after that he was playing…[33]

Thus what would otherwise be a rather mundane discussion of the significance of the difference between the titles of Psalms 23 and 24 turns into an interesting observation concerning involuntary and voluntary ecstatic experiences. According to this midrash, the phrase 'To David, a Psalm' is used for those psalms composed by David when, stirred by the Holy Spirit, he experienced an involuntary ecstatic experience resulting in him singing and playing the lyre. The alternative scenario, however, is the one that concerns us more. According to this midrash, the title 'A Psalm of David' indicates not only a psalm received when David sought an ecstatic experience of his own volition, but also the actual words used while playing the lyre to summon the Holy Spirit. It would appear that, underlying this midrash, is an exegesis of the narrative of Saul's madness, in which it was the combination of singing and playing that was spiritually potent.[34]

This combination is a common feature in the ancient near east. For example, it is clearly discernable in ancient Egypt, as the Rebuke Addressed to the Dissipated Scribe demonstrates. Beginning 'I am told that you have abandoned writing', the teacher rebukes his old student for abandoning the scribal art and pursuing immoral pleasures such as intoxicating drink and cavorting with prostitutes. While reminding the errant scribe of his privileged education, the teacher refers to his musical instruction, which included singing to the music of the lyre:

Papyrus Anastasi IV, 12.2

sb³.tw.k
    ḥsy m-s³ w³ḏn
    r g³ m-s³ w³r
    r ḏd-m-ꜥnn m-s³ knnr…[35]

You were taught
    to sing accompanying the pipe,
    to chant[36] accompanying the w³r,[37]
    to speak with ꜥnn accompanying the lyre…[38]

The verb used in the final clause, ḏd-m-ꜥnn' 'to speak with ꜥn' is noteworthy on account of its suggested relation to the Hebrew root ענה 'to answer, sing'.[39] If this is indeed the correct understanding of this phrase, then the act of ḏd-m-ꜥnn' m-s³ knnr refers to 'speaking in response to the lyre'.

This is more than simply accompanying the music of the strings. In ancient Egyptian tradition, Thoth invented the lyre using sinew taken from the slain Seth to make the strings.[40] This reflects neighbouring traditions in which the sound of the lyre was said to be the voice of the dead animal from which it was made.[41] If the music of the lyre's strings was held to be the voice of the dead (be it deity or animal), then speaking in response to the lyre would be, in effect, communicating with the slain one.

In Mesopotamia, the same combination is discernable in the Gudea Cylinders, which twice describe the temple lyre thus:[42]

Gudea Cylinder A, VI.24-25 & VII:24-25

balag-ki-ága-ni[43] ušumgal-kalam-ma
ᵍⁱˢgù-di mu-tuku níg-ad-gi₄-gi₄-ni[44]
His beloved lyre, *Ushumgalkalamma*,
the renowned musical instrument/sound,[45]
his counsellor.[46]

Ushumgalkalamma means 'Great Serpent of the Country/Nation'. As Jacobsen noted, kalam usually refers to the land of Sumer,[47] hence Falkenstein's translation of this name as 'Dragon of the Land of Sumer'.[48] According to Falkenstein, not only is Ningirsu's lyre thus personified, he is also presented as the foremost musician in Ningirsu's divine court.[49] Thus he is referred to as nar ki-ág-a-ni 'his (*i.e.* Ningirsu's) beloved singer/musician',[50] who leads the singing in the temple.[51] The personification and deification of the lyre as divine counsellor was common in the ancient near east,[52] and reflects the association between the Mesopotamian mantic and scribal wisdom tradition in general and the lyre, confirmed by Enki's status as patron deity of both.[53]

This was not simply theoretical. In practice, the temple was described as follows:

Gudea Cylinder A, XXVII.12
šag₄-bi nam-šub šir-ḫa-mun[54]
Its inner part (is a place of) incantation,
a bilingual/clashing/corresponding (?) song,

The meaning of ḫa-mun is unclear. The Akkadian equivalent, *miṯḫurtu*, is usually thought to mean 'conflicting, clashing, contrasting', with the alternative meaning 'corresponding' not being so well attested and possibly resulting from a problematic reading.[55] It seems clear, however, that the translations 'harmonious singing'[56] and 'singing in close harmony'[57] should be rejected. Krispijn argues convincingly that the most likely meaning is 'bilingual'.[58] Rather than referring to an incantation being bilingual or multilingual, *i.e.*, in Sumerian, Akkadian, Subaro-Hurrian and/or Elamite,[59] however, it is possible that the incantation's bilingualism relates to the two different speakers, *i.e.* the voice and the lyre. This would account for the perceived potency underlying its use in incantations in a temple context. Despite the uncertainty surrounding the meaning of

ḫa-mun, it is clear that there was a close relationship between the incantation and the song. Oracles would be given by priests to the accompaniment of the lyre.[60]

One room in the temple is described thus:

Gudea Cylinder A, XXVIII.17

a-ga-balaĝ-a-bi gud gù-nun-di[61]
Its rear lyre-hall (is) a bull making a loud sound.

This is probably a reference to the zoomorphic form of the lyre.[62] It is possibly also a reference to a belief that its sound is the voice of the slain bull.[63]

Once again, therefore, we see the significance of the combination of voice and lyre, and the strong suggestion of an underlying belief in its sound originating from another realm. Thus the importance of singing while playing the lyre can now be better appreciated. What has been observed in ancient Egypt and Mesopotamia, as well as in early Jewish texts, reflects a deeply embedded tradition that singing while playing the lyre establishes a special connection with another realm and can accomplish something on a spiritual level, hence the association of the lyre with the mantic wisdom and scribal cultures.[64]

Notes

1 Bharyo, S., "'He shall play with his hand, and you shall be well': Music as Therapy in I Samuel 16:14-23", in Burnett, C., & Csepregi-Vardabasso, I., (eds), *Ritual Healing in Antiquity and the Middle Ages,* (London, forthcoming). This paper was itself a follow-up to Bharyo, S. (2003/2004) "The madness of King Saul", *AfO,* 50: 285-92.

2 See, for example, Hamilton, J.R. (1973-London) *Alexander the Great:* 32.

3 Compare, for example, Amos 2:2 and Zephaniah 1:16. Thus Engel wrote of ancient Egyptian military music consisting of a 'trumpeter, a drummer... and two persons who are clashing together a pair of cylindrical maces or crotala' - see Engel, C. (1864-London) *The Music of the Most Ancient Nations:* 248-9 (with illustration). See also Farmer, G.H. (1950-London) *Military Music:* 10.

4 'rod of appointment' – *i.e.,* the appointed rod (or 'rod of his appointment', *i.e.,* his appointed rod, if the ה is read as the masculine pronominal suffix – see note 6). It has been suggested that מוסדה should be read as מוסרה, giving 'rod of his chastisement' – see, for example, Watts, J.D.W. (1985-Waco) *Isaiah 1-33,* Word Biblical Commentary, 24: 403. The Dead Sea Scrolls, however, clearly support the reading with ד rather than ר; compare 1QIsaᵃ XXV 19 – see Cross, F.M., & Trever, J.C. (1974-Jerusalem) *Scrolls from Qumrân Cave I.:* 32.

5 'weapons of elevation' – *i.e.,* weapons poised to strike. The Hebrew term תנופה was traditionally translated 'wave-offering', *e.g., BDB*: 632. Milgrom, however, having compared the Hebrew root נוף with Arabic *nawfã* 'to be high', states that the 'prevalent connotation of this verb is not 'to wave' but 'to elevate' and, furthermore, 'it can be shown that in many instances where the notion of 'waving' has been assigned, the sense will be greatly improved once הניף is rendered as 'elevate' – see Milgrom, J., 'An Alleged Wave-Offering in Israel and in the Ancient Near East' (1972) *IEJ,* 22: 33-8 and p. 34. Thus, of the phrase תנופה מלחמות, Milgrom states that they are 'clearly weapons poised to strike (*cf.* Hos.,1:7; Ps.76:4)'. Various modern commentators, apparently unaware of the militaristic associations of the lyre, have sought to radically reinterpret this verse. One popular suggestion is to emend

מלחמות 'weapons' to מחלות 'dances', and thus change the imagery of warfare to that of a celebratory party, with music and dance, at which those present rejoice at the downfall of Assyria – see, for example, Blenkinsopp, J. (2000-New York) *Isaiah 1-39,* Anchor Bible, 19: 423. Not only is this emendation unnecessary, but it also dramatically alters the sense of the verse, removing the military aspect that the wider context demands. Again, not only do the ancient translations and Hebrew manuscript tradition confirm the reading מלחמות, but also, as we shall see, the earliest commentaries and antique traditions both allow for such a militaristic interpretation.

6 Although pointed in the MT as בָּה 'against her', it makes more sense to understand the ה as the archaic masculine pronominal suffix, which occurs in the ancient Hebrew inscriptions and occasionally in the Hebrew Bible (*e.g.* Jer.2:3) – see Cowley, A.E. (1910-Oxford) *Gesenius' Hebrew Grammar:* 256 (§91e). This grammatical form seems to have escaped the notice of many modern commentators, causing a number of rather drastic and unnecessary emendations to be proposed. For example, Blenkinsopp states 'the feminine suffixes in 32-33, for the country Assyria, are inconsistent with masculine 'aššûr and with the action here described' – see Blenkinsopp, *Isaiah*: 423.

7 For an introduction to both the man and his work, see Donohue, A.A., 'Pausanias, the Periegete', in Cancik, H., & Schneider, H., *et al.* (eds) (2007-Leiden) *New Pauly: Brill's Encyclopaedia of the Ancient World – Antiquity vol. 10:* cols 648-52.

8 For the text, see Pausanias, *Description of Greece II,* ed. Jones, W.H.S., & Ormerod, H.A. (1927-London) Loeb Classical Library, 188: 106 – in addition to the translation given in this edition, see Levi, P., *Pausanias: Guide to Greece,* (Harmondsworth, 1984): 60.

9 *i.e.,* Athena, whose image at Sparta was housed in a bronze shrine – see *LS*: 1973.

10 For example, according to Hesiod (*Theogony* 95), the muses are the divine patrons of those who play the kithara – see Anderson, W.D. (1994-Ithaca) *Music and Musicians in Ancient Greece:* 52.

11 See, for example, Gabbay, U., 'The Balaĝ Instrument and Its Role in the Cult of Ancient Mesopotamia', in Goodnick Westenholz, J., Seroussi, E., & Maurey, Y., (eds), *Sounds from the Past: Music in the Ancient Near East and Mediterranean Worlds.* Jerusalem, forthcoming.

12 Darnell, J.C. (2002-Chicago) *Theban Desert Road Survey in the Egyptian Western Desert: Volume 1. Gebel Tjauti Rock Inscriptions 1-45 and Wadi El-Ḥôl Rock Inscriptions 1-45*, Oriental Institute Publications, 119: 93-4.

13 Langdon, S. (1913-Paris) *Babylonian Liturgies: Sumerian Texts from the Early Period and from the Library of Ashurbanipal.* : xxix – by 'private psalmist', Langdon is referring to the *nâru.* See also the frontispiece in Engel, *Music...,* which shows a British Museum bas-relief portraying the use of harps in such a victory parade.

14 A type of sectarian commentary found among the Dead Sea Scrolls – see Charlesworth, J.H. (2002-Grand Rapids) *The Pesharim and Qumran History: Chaos or Consensus:* 1-16, 68-70.

15 For the *editio princeps,* see Allegro, J.M. (1968-Oxford) *Qumrân Cave 4: I (4Q158-4Q186),* Discoveries in the Judaean Desert, 5: 25-6 and pl. VIII.

16 For the full range of possible meanings, see the very useful entry in *DCH,* IV: 420-4.

17 Allegro, *Cave 4:* 26.

18 Horgan, M.P. (1979) *Pesharim: Qumran Interpretations of Biblical Books,* The Catholic Biblical Quarterly Monograph Series, 8. Washington DC: 103.

19 García Martínez, F., and Tigchelaar, E.J.C. (1997-1998-Leiden) *The Dead Sea Scrolls Study Edition.* Vol. 1: 326-327.

20 For the *editio princeps,* see Sukenik, E.L. (1955-Jerusalem) *The Dead Sea Scrolls of the Hebrew University.* Jerusalem, plate and photograph 39 – note that, in Sukenik's edition, this section is referenced as column 5. See also Licht, J.,(1957) ממגילות מדבר יהודה: מגילת ההודיות: 106.

21 For a full discussion of this verb, see *DCH*, V: 771-772.

22 This is not the usual use of this verb, but, as it only occurs thirty-four times in the Bible, the few occurrences with this meaning are statistically significant – see *DCH*, II: 565-566.a

23 Bhayro, 'Music as Therapy'.

24 For the *editio princeps*, see Sanders, J.A. (1965-Oxford) *The Psalms Scroll of Qumrân Cave 11 (11QPsᵃ)*, Discoveries in the Judaean Desert, 4: 48, 91-3 and pl. XVI.

25 Understanding the ו following each term in the explicative sense – see Cowley, *Hebrew Grammar:* 484 (§154a, n. b).

26 For the text and translation, see Josephus, *Jewish Antiquities Books VII-VIII,* ed. Marcus, R. (1934-Cambridge MA) Loeb Classical Library, 281: 166-167.

27 Josephus states that he had spent time among the Essenes in his late teens – see Josephus, *The Life. Against Apion,* ed. Thackeray, H.St.J. (1926-Cambridge MA) Loeb Classical Library, 186: 4-7. See also Beall, T.S. (1988-Cambridge) *Josephus' Description of the Essenes Illustrated by the Dead Sea Scrolls,* Society for New Testament Studies Monograph Series, 58: 34.

28 As well as his discussion of the meter of Jewish poetry in this section, Josephus continues with a description of the musical instruments in the next section (§306) – see Josephus, *Antiquities*: 66-167.

29 On the cultic prophet and cultic prophecy, see, for example, Jasper, F.N.(1967) 'Early Israelite Traditions and the Psalter', *VT*, 17: 50-59; Hilber, J.W. (2007) 'Cultic Prophecy in Assyria and in the Psalms', *JAOS*, 127: 29-40.

30 Sanders, *Psalms Scroll:* 93.

31 For an introduction to Midrash Tehillim, see Stemberger, G. and Bockmuehl, M. 1996 *Introduction to the Talmud and Midrash,* second edition. Edinburgh, T & T Clark: 322-3.

32 Text from Buber, S. (1899) ילקוט המכירי על ספר תהלים, בראדיטשוב,: 160.

33 Translation based on that of Braude, W.G. (1959-New Haven) *The Midrash on Psalms,* Yale Judaica Series, 13. I: 336-8.

34 This is very much reminiscent of the shamanistic aspects discussed in my previous paper (Bhayro, 'Music as Therapy').

35 For the text, see Gardiner, A.H. (1937-Brussels) *Late-Egyptian Miscellanies,* Bibliotheca Aegyptiaca, 7: 47.

36 The meaning of the verb g³ is unknown, so the translation 'to chant' is a guess based on the context – see Caminos, R.A. (1954) *Late-Egyptian Miscellanies,* Brown Egyptological Studies, 1: 186. See also *DLE*, IV: 50, which notes that it could mean 'to whistle'.

37 The meaning of w³r is uncertain – *DLE*, I: 101, tentatively suggests 'lute', while Caminos, *Miscellanies*: 182, gives 'w⁽³⁾r-flute'.

38 In addition to the translation in Caminos, *Miscellanies*: 182, see the translation by Foster, J.L. (2001-Austin) *Ancient Egyptian Literature: An Anthology:* 49-50.

39 Caminos, *Miscellanies*: 187. Although the various Hebrew dictionaries tend to list these as separate verbs, a cautionary note is often inserted, *e.g.* 'ענה III sing (distinction from ענה I *answer* not alw. clear)' – see *DCH*, VI: 499. It is highly likely that these are in fact the same verb, and that its semantic range is quite broad.

40 Manniche, L. (1975-Berlin) *Ancient Egyptian Musical Instruments,* Münchner Ägyptologische Studien, 34: 91.

41 See, for example, West, M.L., Homeric Hymns, Homeric Apocrypha, Lives of Homer, (Loeb Classical Library, 496, Cambridge MA 2003): 114-9; see also Bhayro, 'Music as Therapy', where this is discussed in more detail.

42 Gudea, son of Ur-Bawa, ruled the Sumerian city-state of Lagash, in southern Mesopotamia, at the end of the 3ʳᵈ millennium BCE. Among the texts that attest to his reign are two clay cylinders, plus fragments of at least two others, discovered at Lagash. For a brief introduction and translation, with notes, see Jacobsen, T. (1987-New Haven) *The Harps That Once… Sumerian Poetry in Translation.* : 386-444.

43 Gudea Cylinder A, VII:24 reads balag-ki-ág-e.

44 For the text (with a useful translation and notes), see Wilson, *The Cylinders of Gudea:* 36, 40. See also Krispijn, Th. J.H. (1990) 'Beiträge zur altorientalischen Musikforschung. 1. Šulgi und die Musik', *Akkadica*, 70: 1-27, and p. 15.

45 The meaning of ᵍⁱˢgù-di is not certain. It could either be a generic term for a musical instrument or a specific term for a stringed instrument, hence Jacobsen's translation as 'psaltery' – see Jacobsen, *The Harps That Once:* 396. Krispijn understands it as referring to the sound being made, translating this clause as 'die berühmte Laute' – see Krispijn, 'Šulgi und die Musik': 15.

46 See *PSD*, A/3: 18-9. Cf. Krispijn, 'Šulgi und die Musik': 15, where this clause is translated as 'die leise für ihn widerklingt'.

47 Jacobsen, T. (1978/1979) 'Iphur-Kīshi and his Times', *AfO*, 26: 1-14, and p. 9.

48 Falkenstein, A. (1949-Rome) *Grammatik der Sprache Gudeas von Lagaš. I Schrift- und Formenlehre,* Analecta Orientalia, 28: 31.

49 Falkenstein, Grammatik: 31.

50 Gudea Cylinder B, VII.14. The Sumerian term nar (= Akkadian *nâru*) can refer to either a 'musician' in general or a 'singer' in particular – see *CAD*, N/1: 376-379.

51 Gudea Cylinder B, XV: 19-23.

52 So Jacobsen, *The Harps That Once:* 396 (note 33); see also Bhayro, 'Music as Therapy'.

53 This is discussed in more detail by Galpin, F.W. (1937-Cambridge) *The Music of the Sumerians and their Immediate Successors the Babylonians & Assyrians:* 55; see also Langdon, *Babylonian Liturgies:* xxiv-xxv.

54 Text from Wilson, *The Cylinders of Gudea*: 118.

55 See *CAD*, M/2: 137-8.

56 Wilson, *The Cylinders of Gudea:* 118.

57 Jacobsen, *The Harps That Once:* 422.

58 Krispijn, T.J.H. (2008-Bethesda MD) Music and Healing for Someone Far Away from Home, HS 1556, A Remarkable Ur III Incantation, Revisited, in van der Spek, R.J., (ed.), *Studies in Ancient Near Eastern World View and Society presented to Marten Stol on the occasion of his 65ᵗʰ birthday:* 173-93, 180.

59 Krispijn, *Music and Healing*: 181.

60 Galpin, *The Music of the Sumerians:* 53-54.

61 Text from Wilson, *The Cylinders of Gudea*: 122, except Wilson gives ka-nun-di for gù-nun-di.

62 For more on early boviform lyres, with illustrations, see Dumbrill, R.J. (2005) *The Archaeomusicology of the Ancient Near East.* Victoria: 234-51.

63 See note 41 above.

64 Such traditions continue to manifest in Jewish and non-Jewish sources even into the medieval period, *e.g. Sefer ha-yashar* and *Khāmīs bar Qardāhē* – I shall return to this in a subsequent study.

Abbreviations

Journals

AfO: Archiv für Orientforschung, (Vienna)

IEJ: Israel Exploration Journal, (Jerusalem)

JAOS: Journal of the American Oriental Society (Ann Arbor MI)

VT: Vetus Testamentum, (Leiden)

Dictionaries

BDB: Brown, F., Driver, S.R., & Briggs, C.A., *A Hebrew and English Lexicon of the Old Testament,* (1907-Oxford); *CAD:*The Assyrian Dictionary of the Oriental Institute of the University of Chicago, (1956-Chicago); *DCH*: Clines, D.J.A., *et al., The Dictionary of Classical Hebrew,* (1993-Sheffield); *DLE*: Lesko, L.H., & Lesko, B.S., (eds), *A Dictionary of Late Egyptian,* (1982-1990-Berkeley & Providence); *LS*: Liddell, H.G., & Scott, R., *A Greek-English Lexicon,* (9th edition, (1940-Oxford)); PSD: The Sumerian Dictionary of the University of Pennsylvania Museum, (Philadelphia (1984-)

BULL LYRES, SILVER LYRES, SILVER PIPES AND ANIMALS IN SUMER, CIRCA 2500 B.C.

Bo Lawergren

Woolley's Lyres

During the seventh and eighth excavations at Ur, 1927-1929, Sir Leonard Woolley unearthed several bull-lyres. Among them was the golden lyre (fig. 1) hosted in the Iraqi museum until 2003; the silver lyre (fig. 2) is in the British Museum, the largest lyre (fig. 3), is in the University Museum, Philadelphia, and the plaster lyre (fig. 4) which might still be in the Iraqi Museum, was probably never displayed. All have boviform sound-boxes. At the front and rear ends of each are vertical uprights on top of which rests a horizontal yoke. Iconography shows they were played in an upright position (fig. 5), both by humans and animals alike (fig. 6).

Fig. 2

Fig. 1

Fig. 3

All lyres came from the Royal Graves and date around 2500 B.C. It is estimated that the time between the earliest and latest burials was no more than 100 years. Most lyres were of the monumental type with the Philadelphia model being 140 centimetres tall. However, a millennium later an even larger model is depicted on vase from at Inandiktepe in Turkey (fig. 7). There, two standing musicians seem to play on it.

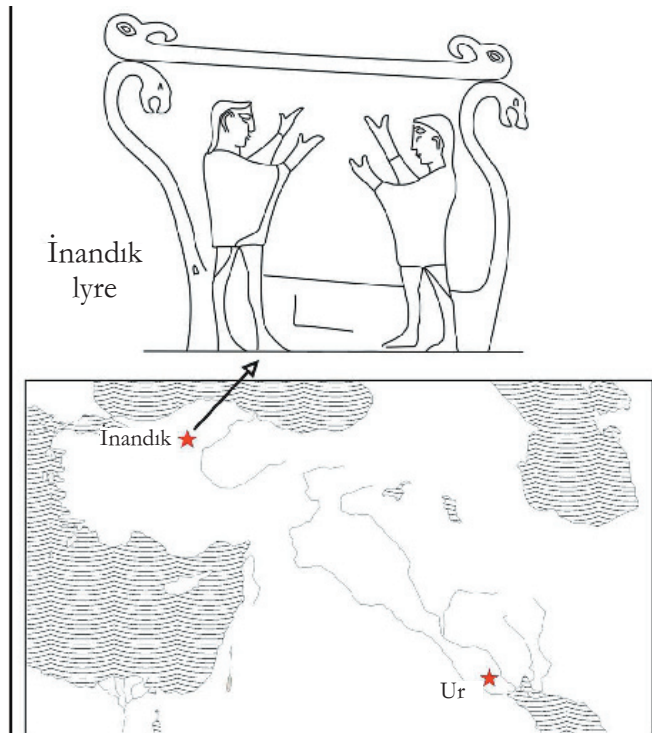Fig. 4

Fig. 5

Fig. 6

İnandık lyre

Fig.7

Most lyres were inhumed flat on their side. In the Great Death Pit several instruments lay on top of one another. Woolley managed to disentangle them satisfactorily. Around the instruments were many female bodies. They wore the most elegant and elaborate headdresses of all others in the grave. Donald Hansen noted that: 'they may well have been the lyrists and singers who took part in the death ritual.'

Woolley found these lyres crushed flat, only revealing their two-dimensional outlines. They were now flat bulls with flat uprights and flat yokes. Somehow he had to bring them back to a 3D shape. A major question arises: were the sides of the sound-boxes flat and parallel to each other or were they convex as they are with the body of a bull? Woolley rendered them all flat. It is possible that he was guided by the straight lines of the extant plaques mounted on the narrow sides. Some are rectangular[1] others trapezoidal (fig. 8).[2] The edges of the broad front or rear sides may have followed these shapes, but even so, the sides may not necessarily have been flat. We have a parallel with a type of lyre played in Egypt during the second and first millennium B.C. (fig. 9). The broad sides at the front and rear curve in all three directions.[3] Clearly, Woolley's choice of flat sides can be questioned. I propose that a closer examination of the cast and reconstruction of the plaster lyre shows evidence that might have escaped Woolley's scrutiny.

It had also been buried vertically and therefore had not been crushed. The wood had decayed and as a consequence had left an empty volume in the soil which Woolley carefully filled up with modelling plaster, probably inspired by his predecessors at Pompeii who

famously did the same, long before, to preserve the shape of bodies. When the soil was removed, the plaster shape of the lyre appeared (fig. 10). It was ornate with a copper head. There were white traces of strings on the soil of which Woolley said they were from decayed gut or sinew. On figure 10, I have marked the strings with arrows, ten in all. Some are not quite straight, probably because the soil shifted, but all converged towards the trapeze which I have outlined in black. This would locate the bridge. It is placed nearer to the tail than to the head of the bull.
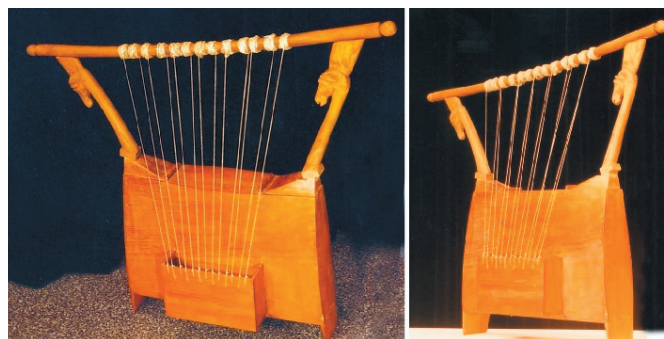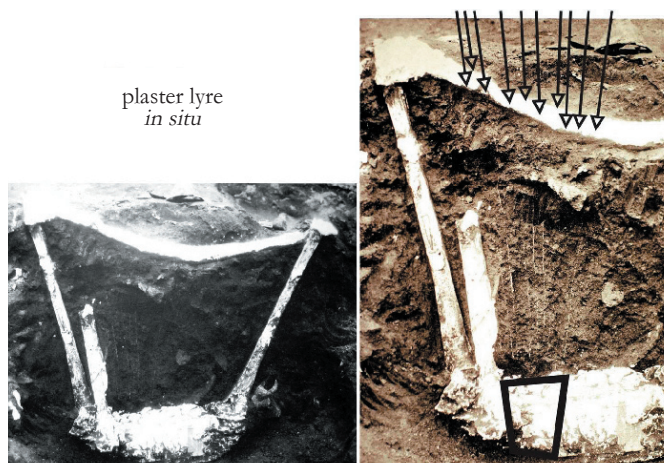
After some preliminary cleaning, Woolley lifted off the lyre, a photograph was taken. This was one of the great moments in the history of archaeomusicology (fig. 11). Three more photos were taken at that time (figs 12 – 14).

Fig. 8

Fig. 11

Fig. 9
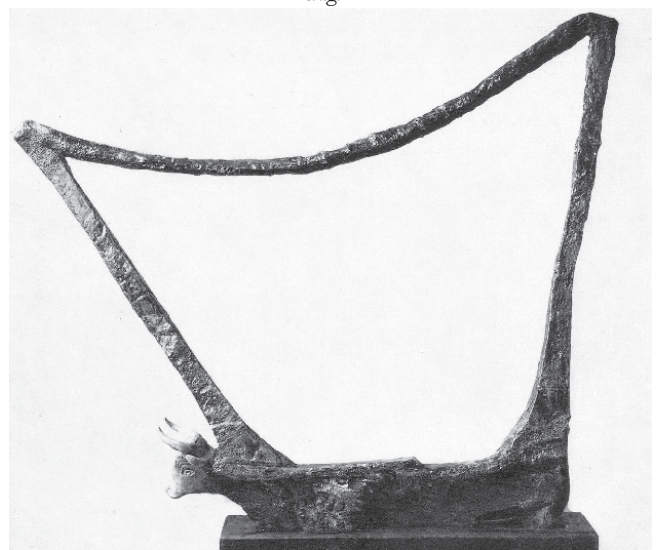

Fig. 12

plaster lyre *in situ*

Fig. 10

Fig. 14

The plaster lyre has received little attention, but in 1988 as I attended the Babylon Festival, the Director of the Iraqi museum, Dr. Bahija Khalil Ismail, kindly allowed me to examine the object in her office. For unknown reasons, the plaster had been painted black. I took some photos (fig. 15) and later made an accurate three dimensional wood model of it (fig. 16).

Fig. 15

Fig. 16

Woolley had only been partly successful in his attempt at filling the cavity as the plaster only revealed one side of the body. The other side collapsed in the process and its original shape was lost forever.[4]

For practical reasons, let us call string-side of the lyre 'the front' as in all cases the bridge is placed on the right side in relation to the lyrist. Unfortunately with the plaster lyre, the eroded side is the front and gives no information about the bridge, its position and its shape. Woolley was confused about it and in the excavation report wrote that:

> The lower part of the sound-box had disappeared and the front below the projecting rim is very rough — this seems to have nothing to do with the original but is due to the dry earth falling away from the face of the mould

and leaving a depression which the plaster reproduced in the reverse. At the back of the sound-box there is a raised ridge which may possibly be the bridge.[5]

There is indeed a ridge on the back but it cannot be a bridge. His suggestion that the soil had fallen and partly filled the cavity seems plausible.[6] Apparently, he did not write anything more about it.

The examination of the preserved side shows (fig. 17) some rough details and there may be some eroded patches here and there but the structure is generally consistent. There is a broad protruding shoulder near the head but there is no corresponding protrusion at the hip. It may have been omitted so as not to interfere with the strings which would have run close. They emerge from the region of the stomach. Perhaps they represent the bull's guts, as well as being made from gut.

Fig. 17

Above the stomach there is the spine, a solid ridge of about 6 cemtimetres wide at the middle. Slightly below the body becomes thinner and the surface is concave. Further down, the body swells to reveal the massive lump of the stomach. This is a realistic feature of bulls (fig. 18). The hip bone is located further back where the body widens again.
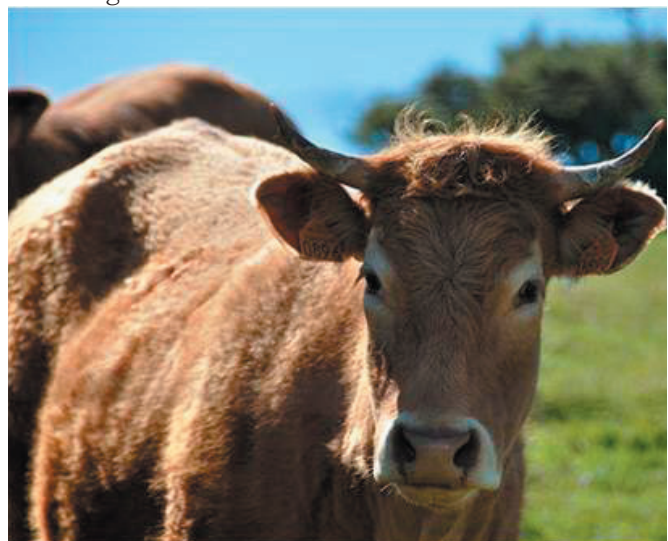

Fig. 18

The photograph above shows the body gently curved on top (fig. 19), where the curve of the back surface [white line at the bottom of the photo] is
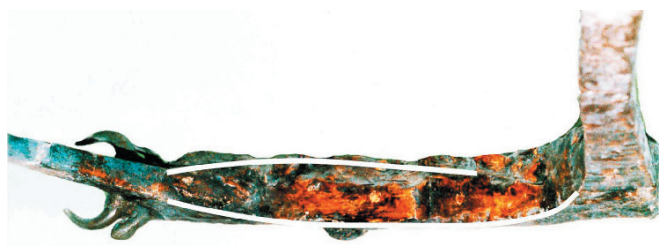
Fig. 19

inversed and drawn on the top surface which did not survive. Presumably, the curve is symmetric, making the body wide in the middle and narrow at the ends. This curvature is similar to that of the bellied Egyptian lyre (fig. 20).

Fig. 20

In 1969 Richard Barnett, then Keeper of the Department of Western Asiatic Antiquities at the British Museum commented on this matter.[7] He was more interested by the silver lyre than he was by the plaster cast. However, he suggested that the silver bull would have been more realistic with a belly, an idea he derived from the Egyptian lyre above and wrote: 'The side-view of the Egyptian lyre shows the sound-box to belly slightly outwards and it is possible that the silver lyre ought to have been so restored, showing an even greater similarity to an animal.'

Fig. 21

A last observation on the replica will focus on a prominent horizontal ridge on the lower hind quarter of the body (fig. 21), the ridge mentioned by Woolley. Real bulls have many skin folds (fig. 22). This might be the reason for the horizontal ridge.
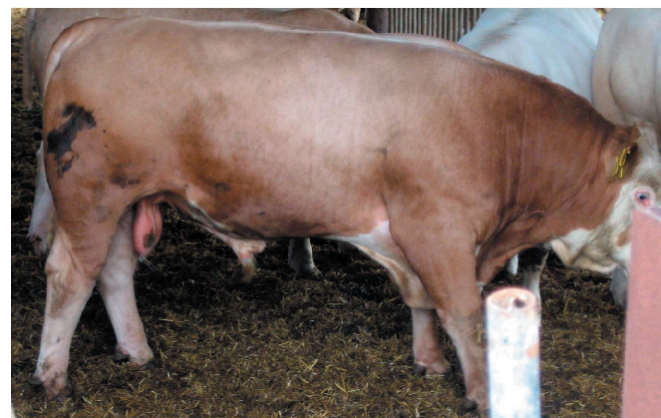

Fig. 22

To summarize, the plaster lyre shows that its sound-box was convex, unlike the acknbowledged reconstructions made by Woolley and others. This throws doubts on flat-sided reconstructions.

There are many representations of bull-lyres on cylinder-seals, and one example gives an effective three-dimensional form (fig. 23). The lyre is seen from the back, and the strings run down the front, but the bridge is hidden.
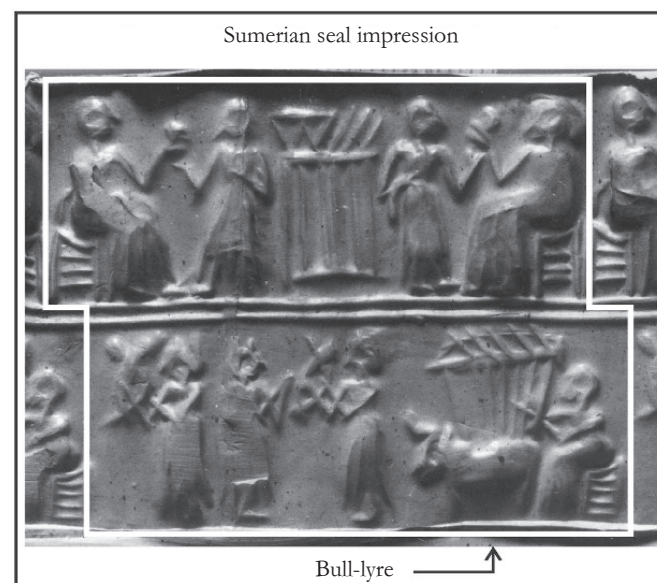

Sumerian seal impression

Bull-lyre ⟶

Fig. 23

Sounds of Lyres and Bulls

Could these lyres also have sounded like bulls? These animals emit deep buzzing sounds. Bull-lyres have wide bridges, about 5 centimetres, the srings might have transmitted their vibrations to it and buzzed. Wide bridges are not seen on Western types and as a consequence they do not buzz. However we find them on Indian sitars and Ethiopian lyres, such as the bagana, which both buzz.

We do not really know if bull-lyres were fitted with wide bridges since none has survived. However, iconography reveals two of them (figs 5 and 6). There, the bridge is wide, but it may not necessarily have buzzed. The effect also depends on how the strings touched the bridge, and it is impossible to judge from the iconography.

Animals making music

Bull-lyres take us to a strange world where animals make music, either as the source of sound, as with bull-lyres, or as players. A most evocative illustration is on the frontal shell plaques of the Philadelphia model (fig. 6): a bull-lyre on a bull-lyre. There the lyre is played by an ass with human hands. It sits on its hind-legs and looks at its two companions. There is a large bear holding the lyre steady and a fox shakes a sistrum.[8] The lyre-bull has long front legs. They are tucked under his body and have the same height as the short legs on extant types. The fox keeps a flat object on its lap. This could be a clay tablet with inscriptions. Since its mouth is opened, it may be the text of a hymn it is singing. There are two instruments and a singer. [9]

Such scenes were not only known to Sumer. There is one (fig. 24) from Egypt, dated 1200-1100 B.C. on a fragmentary erotic-satirical manuscript in Turin. This 'redrawing' has fake colors meant to clarify the picture. A quartet of large animals stand on hind-legs and play music. A monkey blows double-pipes, a crocodile strums a lute decorated with a bird's head, a lion plucks a fat lyre, and a donkey plays an arched harp.

There are many pictures of animals making music, and the subject goes well back in time, even to the Paleolithic. A French cave, les Trois Frères, at Les Eyzies has a drawing of a human disguised as a bull. He/it seems to hold an instrument (flute, reed-pipe, musical bow?) close to his/its mouth. It is dated to 13,000 B.C.

In all cases, except in the Paleolithic example, the protagonists are modelled as real animals, and not as humans in disguise.

Did the ancients really believe that animals could play and enjoy music? We cannot tell but I would like to suggest a possibility: the idea may be connected to a mythological subject told for centuries but now lost. For Sumerians, reality and myth might have been more closely connected than they are for us, and the border more fluid.

Pipes and Mythology

A intermingling of music and mythology can be seen in the case of the silver pipes Woolley found at Ur.[10] They have received little attention, stored in the University Museum, Philadelphia, but never exhibited.

This is understandable when you see the pipes. What were originally two straight pipes (fig. 27) had been twisted and broken before burial. Further deterioration has occurred after the excavation, but early museum photos helped me to arrange and measure the pieces. Their narrow gauge is unusual. Woolley suggested that they were made in imitation of the reeds growing in the marshes.

The pipes had been deliberately crunched into a bundle. This would have made them unplayable at the time of the burial. The destruction contrasts with the non-destructive burial of string instruments at Ur. A known Mesopotamian myth offers an explanation. Pipes were associated with the shepherd-god Dumuzi who was the lover of the goddess Inanna. One story tells of her death and her wish to return to the realm of the living. The wish was granted when Dumuzi took her place in the underworld, a switch the two periodically repeated. The pipes fell silent when he descended to the underworld, but when he returned the pipes played again and the living rejoiced. It might be that the destruction of the silver pipes had been an act in reverence of Dumuzi's in the underworld.

Notes

1 Woolley (1934) PG [private grave] 1332.
2 Woolley (1934) PG 789.
3 Lawergren (1998).
4 Woolley (1934): 256.
5 Woolley (1934): 257.
6 Woolley (1934): 256.
7 Barnett (1969).
8 The lyre has only eight strings, well below the normal complement of 11, Lawergren and Gurney (1987), Tab. 3 derived from extant instruments. Pictures, on the other hand, usually under-represent the number of strings, see Lawergren (1994).
9 For a discussion of animals in Mesopotamian texts, see Wiggermann (1995).
10 Lawergren (2000).

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A SUMERIAN TEXT IN QUANTIFIED ARCHAEOMUSICOLOGY

Ernest McClain

A cuneiform problem text dating about 2500 B.C. is about the partition of a grain constant. It is contended that it also defines a quantified musicology embodying the science of Pythagorean Greece, some 2000 years later.

A challenge to imagination

In the fourth millennium B.C. Sumer invented a base 60 arithmetic which achieved easy correlation between as many as 12 different metric systems emerging in the early development of civilization.[1] Massive documentation of organological experience in the ancient Near East naturally invites attention to plausible quantification in musicology.[2] Regular numbers in base 60 are factored only by 2, 3 and 5 defining just musical octaves, fifths, fourths, and thirds within the cyclic octave 2:1. We consider the question of how the newly correlated cultural constants relate to the cyclic octave 2:1 in which angular values in a tone-circle would explain the quantifiication of the highest deities. Cyclic coincidence with every doubling or halving of defining measures introduces many tricks of our own craft into computation - anticipated and abstracted by Plato in the fourth century B.C.[3] We deploy them freely here in search for the plausible foundations of science, limited to the most elementary tools.

Tablet and transliteration

Two cuneiform copies by students to compute a grain constant of 1,152,000 portions on tablets are small enough to lie in the palm of one's hand. They are identified as TSS 50 and 617. The latter has some errors, and each was recovered from different parts of the ruins of Šuruppak. The total is imagined as partitioned into portions of 7 sila each for

164.571 men with only 3 left over. The students are challenged to restore the dividend by manipulating tokens for six different values: 36.000-3.600-600-60-10-1. Transcription and transliteration in figure 1 clearly expose these values in descending order downward along the right hand column.

Reconstruction of the grain-pile from 164.571 portions with 3 left over
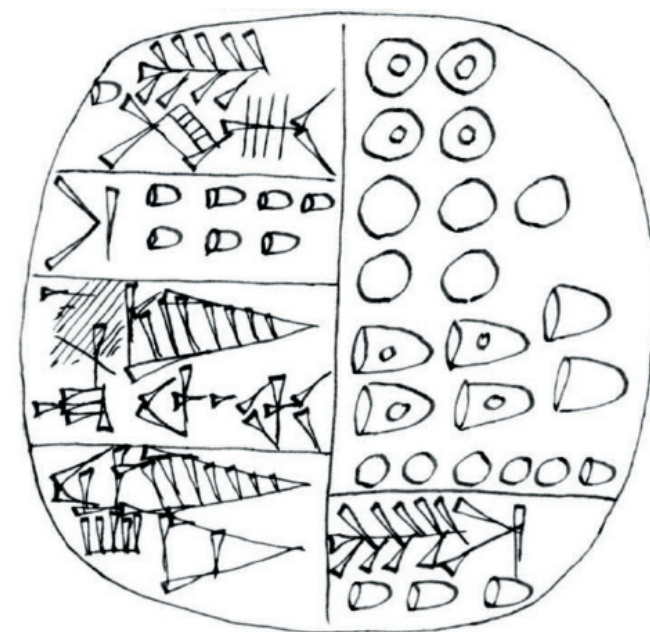
	[36000][36000]
1 še-gur₇	[36000][36000]
sìla 7	[3600][3600][3600]
	[3600][3600]
1 lú	[600][600][60]
šu-ba-ti	[600][600][60]
	[10][10][10][10][10][1]
lú-	
-bi	
	še-sìla
	3

Fig. 1. Hand copy and transliteration

Computing procedure is not explained, and so must be reconstructed. Georges Ifrah displays how 168 tokens for these six values could have been manipulated to find that 32 of the largest replace the many smaller ones needed during the restoration of the dividend (32x36.000 = 1.152.000).[4] The right answer on TSS 50 was first published by Jestin in 1937 and explained by Jens Hoyrup in 1982 as 2400 gur, where 1 gur=480 sila.

Joran Friberg notices a possible alternate summation as 45 42 51 (in non-positional sexagesimal numbers (before base 60 was regularized ca. 2000 B.C). He brings attention to a discrepancy for some unknown reason with attested later grain measures.[5] [Read his notation as 45x3,600 + 42x60 +51 +3.] We accept their agreement on 1.152.000 as the total and ask ourselves the very different question of what 1.152.000 might have meant for early archaeomusicology, studied with clay or pebble markers and with rigorous attention to pattern.

As the upper bound of a tonal limit for a system of octaves, fifths, fourths, and thirds - thus with a lower bound at half - 1,152,000:576,000 defines a model octave 2:1 within which all numerical doubling is merely repetition at the octave and thus cyclic invariance for only 65 products of the prime numbers 3 and 5, computed from any convenient reference unit. We display the answer first laying out factors in the triangular lattice (of fig. 2 suggested by the double glyph for slave girl or mountain woman, already loaded with multiple meanings about the sex of numbers in the downward pointing female pubic triangle in company with a upward pointing phallic triangle of three plano-convex sun-dried bricks as incipient mountain). Triangles mate to inseminate with seeds of the first example of multiplication by 3, and Platonic children must not be allowed to let their feet touch the ground until the age of 3. In this model known now as Egyptian duplatio, the unit is merely doubled and then added to itself to achieve multiplication by 3. In turn 3 is doubled to 6 and added to model what follows to any limit of interest - 12 successive times in the base of this pile, represented by 13 anonymous symbols perfectly disciplined for higher purpose. But doubling the unit reference twice to 4 and adding 1 to reach 5 takes us stepwise upward along the left as reference for a second row of tripling, and another step doubling 5 to 10 and 20 and adding to 25 follows to map the pattern of ascent along all right-leaning diagonals ///… by 'fiving.' These first examples can be iterated to exhaust the pile of factors of 3 and 5 to a height of 9 rows, with each referent then tripled to the right to the maximum within 1.152.000, leaving a jagged descent on the shoulders along the right as remainders, and not directly computed. In the ratio theory known to the Greeks as music only one part ever is manipulated (i.e., either by octave doubling in multiplication by 2, suppressed visually here), or by doubling and appropriate summing. As a consequence harmonic joinery is always achieved as n+1 or n-1, illustrated by Claudius Polemy in the second century A.D. in saving some 20 ancient systems. All other ratios emerge as cut off by these favored few, exploiting the first three primes.

Spiral fifths tuning as cosmic foundation
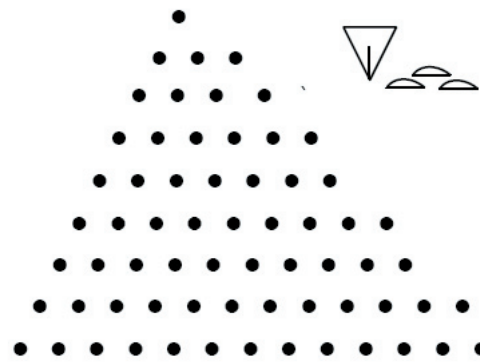
The thirteen tones of the familiar serpentine

Fig.2. The grain-pile of 1.152.000 as 65 potential tone numbers.

spiral of musical fifths and fourth are the 'Great Serpent' foundations of ancient musical mythology, split into three parts offset now by a trivial syntonic *comma* (80:81) and so enjoy the same modern alphabetical names, differentiated here by upper and lower case typeface. The Sumerian metaphor of 'lion of the ground' echoed in the Bible's serpent as more subtle than any other wild creature that the Lord God had made (Gen 3:1), remains felicitous for three small serpents belonging to slightly different spirals intricately paired. This creature, Marduk's favorite - the mušhuššu dragon - proves seven-headed in alternate ways.
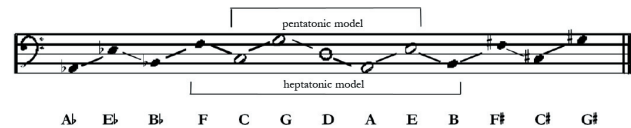

Fig. 3. Spiral fifths expose a new pentatonic simplicity when heptatonic systems are fully understood.

Just tuning is a derivative set of 15 elements - eventually deified by Inanna as goddess 15 - realigned in standard offset brick arrays that are read today perhaps anachronistically as nested major and minor triads. Every atomic triangle of nearest neighbours appears to us as a major triad when upright and as minor triad when inverted, but it remains questionable whether ancient attraction was the secondary tonal consonance of just major thirds of 5:4, or arithmetic simplicity. We imagine this pattern of 15 elements to be Inanna's bed with moveable chair as temple virgin in multiple ways, for 15 cannot be halved in base 10 integers, and doubles into Sin, the moon, as god 30, and again into Anu, the 'do-nothing' referent of base 60 arithmetic as god 60. The first and last elements of the just set now are 1st (a^b) and 15th(g$^#$) when viewed from the tonic center, and the matrix is contrived to eliminate their appearing together as reciprocal near approximations to the square root of 2 in the middle of the octave (as paired tritones from D). The defining cornerstone thus enjoys two tonal incarnations in base 10 reciprocation whereby it greatly reduces numerosity, functioning as Inanna's moveable chair. Notice the triangles on the ends of the long axis of the rhombic alignment.
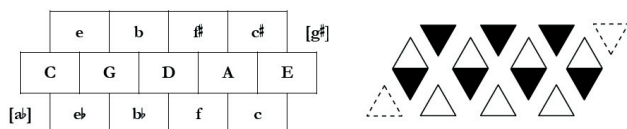
Fig. 4. The derivative pentatonic subsets.

Inanna's bed and throne as goddess 15 and temple virgin is a portable pattern freely moved up and down and right and left within the limits of the grain-pile or any larger matrix as a privileged subset, but eventually sealed in place by the defining limit. This motif of nested triangles is exploited in Samarra ware pottery and wall decor a thousand years or more before needed for base 60 musicology. The ratios of the just system are defined from the middle by a roseate seven initial elements (as the grain-pile itself is divided into portions of 7 sila), an early notation for 7 made by indentations in the clay with a rounded stylus, and enjoying various symbolic astral associations as gods.[6]

Fig. 5. Early patterns.

Another early notation for 7 can be read as paired triples or tripled pairs as if describing Gilgamesh in the first of the 12 tablets of the epic named for him:

Surpassing all other kings, heroic in stature,
brave scion of Uruk, wild bull on the rampage!
Going at the fore he was the vanguard,
going at the rear, one his comrades could trust.[7]

The atomic lattice as a net of the gods

In figure 6 the male products of 3 and 5 are laid out first as fighting men to a limit of 60 to organize computation and identify the gods, eliminating distracting duplication in this initial horned octave exposing gods 30, 40, 50, and 60 as Plato's formal plethra (full) as 6:3 meaning 3-4-5-6.[8]
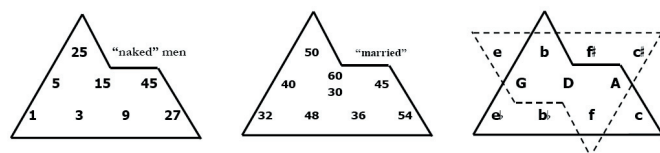

Fig. 6. The model matrix for the 60:30 octave in training for a metaphysical wrestling.

The reduced male factors are doubled as many times as necessary (*i.e.*, they are married to the female 2), to lie within the octave 60:30 as upper and lower bounds. (And that doubling may very well have been done in vertical counting board arrays, as some suggest.)

The new matrix then is imagined as symbolically tonal and is rotated half-a turn (180°, as if overturned by an earthquake) to map reciprocation in familiar base 10 notation, allowing suppression of base 60 reciprocals that regular numbers enjoyed to infinity without remainders (and that we suppress here for simplicity). Mesopotamian devotion to perfect inverse symmetry favors assigning modern pitch class D to the largest integer in every example to make them directly comparable tonally under confusing arithmetical transformation. Musicians tuning by ear wrestle with this problem in their own ways, but not arithmetically. The resulting ratio numbers required for scale order now appear to the eye as a tower of Babel until realigned into linear and cyclical scale order (increasing or decreasing) as displayed below. They function now as ratios of string or pipe length, or - in later physical theory - reciprocally as frequency ratios - but the perfect symmetry of preferred patterns was indifferent to both physics and reciprocal modes.

Asymmetric tetrachords ratios rise or fall tonally and thus create oppositely paired tonal models that integrate eleven pitch classes. 'Cutting the serpent' in two places (C and E to produce c and e here) creates a related just tuning system with pure major thirds of 5:4 that defines pitch classes in no more than 2 or 3 modern digits (instead of 6 digits) for 12 tone theory. Plato used spiral 5ths ratios (confined to the middle row) for his heptatonic World Soul (with cyclic discrepancies of no more than half of a *comma*) and just ratios for his political theory. Ptolemy in the second century A.D. saved the ratios of both systems, and he correlated spiral 5ths with his zodiac, related to precession (that Plato denied understanding in the fourth century B.C.), as if the systems were interchangeable. Kepler carefully studied the just ratios of Plato's politics to develop his own theory of slightly elliptical planetary cycles rather than Plato's assumed perfect circles. Consequently these are two of most seriously studied systems, as intertwined in history as the serpent itself.

falling	mi	re	do	ti	la	sol	fa	mi	ancient
rising	do	re	mi	fa	sol	la	ti	do	modern
falling	D	C	B♭	A	G	F	E♭	D	ancient
rising	D	E	F♯	G	A	B	C♯	D	modern
Just	60	54	48	45	40	36	32	30	primes 2, 3, 5
3rds	72	80	90	96	108	120	135	144	
Spiral	384	432	486	512	576	648	729	768	primes 2 and 3
5ths	972	864	768	729	648	576	512	486	

Fig. 7. The 'World Soul' in a related just tuning with thirds of 5:4. The abstract pattern of tetrachord ratios may rise or fall tonally, and thus increase or decrease in numerosity according to physical application. The organology of the ancient Near East testifies to long and rigorous empirical experience ion quantification. This is the most rigorously studied scale in the history of musicology.

The Sumerian system we explicate in Platonic arrays is based on the multiple meanings of seven that arise from knowing that a perfect fifth of 3:2 embraces seven semitones, so that its complementary musical fourth of 3:4 embraces five and results are the same when tuning proceeds in either direction. Origins remains lost in the stone age. We merely harvest the insight that counting clock hours in sequence as semitones suffices for a ritual musicology correlated with clock and calendar. Inanna tends the damaged tree of life not with her hands but with her feet. This is easily imagined from the stick figure of a human as image of the pentatonic scale, and the pattern can be drawn without lifting a pen from the paper or a stick from the sand. The figure itself is an ancient glyph for a star, and a symbol for heaven when encircled. Its feet at 7 and 5 o'clock locate Plato's paired arithmetic and harmonic means (modern dominant and subdominant) framing normative tetrachords (sets of four consecutive strings) within all but one of seven diatonic modes when the head points to the tonic reference above. In 1945 Neugebauer and Sachs identified these twins as first approximations to the square root of 2 in the middle of the octave.[9] The tritone lying between them lies seventh in each direction from the middle (as 1st or 13th) in linear scale order, and that tritone is the identifying interval of the mode in Mesopotamian tuning theory - as we learned from the seminal decoding of Kilmer, Crocker and Brown. They surprised our profession with a brilliant system applied to a nine-string lyre Greece seems not have known, described twice (from each end of our serpent). Strings were identified not by lengths but merely by order, so that clarifying the tritones seriatim (reducing them to perfect fourths or expanding them to perfect fifths to restore this wholetone between them) cycles through six different modes where the system must stop or lose its bearings, with the original tonic throne itself moved by a *comma*. The outer two pairs of strings were always tuned in octaves, so that only 7 different pitch classes were embodied in any mode. Pentatonicism is free of defining tritones, for the first semitone appears only with the sixth pitch class. Rotate the next page to see spacing in 5 different modal pentatonic patterns, but sing the scale with do re mi sol la in either direction and notice how readily the 5 modes merge into one happy family, however far extended.

Barefoot musicology is not yet normative in academia, but perhaps ought to be. In India 4 - armed Indra dances gracefully on one foot, and Hephaestus (the armorer) amuses other Greek gods with his club-footed limping, and Inanna's feet as Lady of the Night merit close attention.[10] Her legs terminate in the giant claws of a bird of prey, and three toes on each foot are graced with enormous talons that can be imagined as dividing the circles drawn with a compass (a forked stick would have sufficed in Sumer) six times into double hours of the day and again of

the night, adjusted monthly or fortnightly for their variable lengths, and then reused for division in 12, assumed - not computed in Mesopotamia - as the measure of both circumference and area long before they became Platonic points of no dimension. Sumerian naked-eye observation needed a quarter-hour to detect a change in stellar position, correlating conveniently with quartertones, for in musical performance the smaller *commata* are often safely ignored (and sometimes preferred for the color they introduce).

Fig. 8. Inanna as Lady of the Night.

Very small ratios were not observed with high accuracy in either astronomy or music, but rather computed from cumulative discrepancy over longer intervals. Science was driven by fascination with the right numbers while multiplying three primes whose higher powers never agree more closely than within a single digit. Inanna's 15 plus 1/15th (of itself) sums to 16 to illustrate a general restriction to unit fractions and the 15:16 semitone characteristic of just tuning, within which musicians experience the syntonic *commata* of 80:81 (*i.e.*, $(5x2^4):3^4$) is the difference between wholetones of 8:9 and 9:10, ratios probably discovered by scribes with restless curiosity and alert to their own problems. Self-reference to other contexts is a marked characteristic of ancient musicology that repeatedly surprises with unanticipated coincidences, forbidding certainty about authorial intention, and teasing a modern reader's fancy. A clay plaque from the period of the grain-pile displays the lady's charms as she stands on a

pair of peacefully recumbent lions of the ground holding the rod and ring of authority in each hand. We pursue her arithmetic with this clue that a higher magic lies in her feet, illustrated in the five-pointed star glyph that visually maps the pentatonic scale associated with her apotheosis here. Locating one tone ensures that its reciprocal lies opposite at right angles to an imaginary plumb line from above, and successive pairs in either system can be located with surprising accuracy by our dance of the hours.
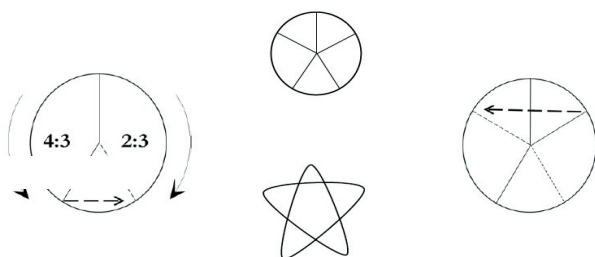

Fig. 9. Foot-work.

Base 60 as a saltation in metaphysics

From the parochial view of musicology the invention of base 60 made possible the easy calculation of the spiral of fifths and fourths in symmetrically opposite directions without encountering continued fractions that arise when 10 is divided by 3 (as in 3.333…) Henceforth imagination could compute multiplication and division of 2, 3 and 5 endlessly with perfection, so that metaphysics now possessed a trinitarian infinity. The new limit of 60 exposes its gods numerically first within the limit of 60 in figure 6. We build all matrices on this single model.

1) Lay out products of 3 and 5 in offset 'brick' alignment.
2) Double to the limit within its half at 60:30.
3) Read left to right as potential spiral fifths, with 'D' as upper and lower limits, and ascend by major thirds of 5:4 along diagonals / / /; minor thirds of 6:5 lie on opposite diagonals \ \ \.
4) Frame the pattern and rotate it 180 degrees in either direction to realign tonal-arithmetical reciprocals at equal distances on straight lines through the middle on D, thus avoiding in base 10 any need for the new reciprocals that would inflate numerosity.

We meet the result as the radiance of ten gods in all holy mountain computing matrices and later granted to Babylonian Marduk at birth as his Sumerian patrimony, but notice that radial angles are very different when bent round in a circle for Platonic convenience.

Inanna as goddess 15 and temple virgin served all male suppliants as mistress of the matrix and eventually was identified and carefully tracked as both morning star and evening star. In the 60:30 matrix she grounds Sin the wayward moon, god 30, at his mid-month festivals and Anu,

god 60, as do nothing referent for the pantheon. But she is imagined as the daughter of Ea, the creator deity as god 40 meaning two thirds of sixty, and in Sumerian metaphor 15 understood as 3x5 is indeed his first child as his own initial 5 is doubled three times by 23=8 into 8x5=40 (as if a Platonic son of his own daughter). In the Gilgamesh epic his reciprocal as 3/2x60 =90 is a wild man of the forest outside the civilizing matrix, diminished by half, however, into 45 (accomplished by a clever strategy of the gods by a week's copulation with Uruk's prostitute. She is sent to entrap him, and knowing her awakens his moral sensitivity and eagerness to confront Gilgamesh who, as two thirds god and one third human shares the initial 40 with Ea, the creator, and claims the right of first night with all of the city's brides. He enters Uruk, trips Gilgamesh, they wrestle to a Platonic draw, and Enkidu becomes both servant and best friend. He is immediately recognized by mother Wild Cow Ninsun, the hero's mother, as a twin she might have birthed herself. Only music appears to offer rational deification of Sumer's pantheon but only in company with Sumerian art, mathematics and mythology.

The active leader of the pantheon is Enlil as god 50, doubled from 25, bull of the mountain and the only deity besides Ea already with a reciprocal at 36 within the basic matrix (through the center). Thus reciprocation rotates him between the third and first rows so that he also plows the earth as Lord of the Plow, his personal symbol. This leaves him easily confused about which role he is playing as the leading exemplar of reciprocation. Creator Ea's reciprocals of 40 and 45, however, lie on the horizontal axis as plane of reflection between above and below and thus he remains a member of the same tonal spiral - never confused in any crisis but firmly refusing, like the other deities, to face demonic Tiamat when she threatens to destroy the gods, now multiplied and noisy, to whom she has given birth from below (in the salt water below Ea's second row of sweet water). Ea's role as keeper of order (the me) in all of the arts and sciences of civilization is symbolized by inserting the flattened end of a stylus into the clay twice at right angles to itself. This old Sumerian symbol survives in a double sense when Marduk is given the four winds to play with at birth, but his own symbol is a four-pointed star aligned to function as both plumb line and balance beam, and Ishtar's later symbol is an eight-pointed star enjoying similar rectitude. Mantels of radiance given the gods have related but very different positions in cosmic circles when the cyclic octave double is treated not as a plane of truth but as 360° in a circle. Inanna steals the me (cosmic order) from father Ea in a family drinking bout, about which he laughs, but he also goes to considerable trouble to recover them. For unknown reasons the scribes eventually rotated their own writing tablets 90°, including the glyph for mountain woman. Friberg notices that standard

Babylonian multiplication tables generally begin with a reminder of the importance of two-thirds, and then proceed to present 2 and 30 as first paired reciprocals. [The reciprocal of 40, however, is presented later in its proper turn as 1,30 meaning one plus one-half]. Nothing that Sumer invented seems ever to have been lost. Šamaš the sun as god 20 is priceless: as one-third of 60 he is a mathematical constant that sees everything. As 60-20=40 and 60+20=80 he commands the octave 2:1 that Enki and Gilgamesh both ground as two-thirds in its role as creator. Nature is serving music in endless ways. Before proceeding, look at again the naked wrestling in figure 6 to confirm that reciprocation of the model requires four numerical elements in the third row.

The musical brick constant of 720

In figure 10 we see the coincidence between the cultural constant of 720 in which bricks were counted, strangely indifferent to size, shape, weight, coverage, quality, etc., and the irreducible 12 tone constant of 720:360 which gives Platonic logical necessity to reciprocals of the favoured modal patterns.
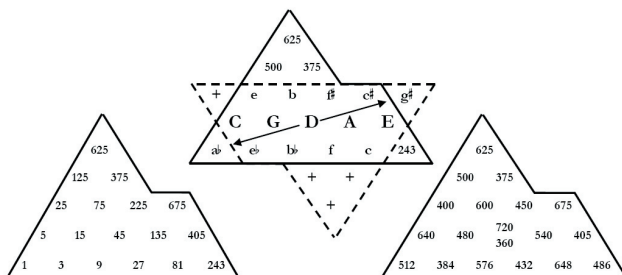

Fig. 10. (See enlarged graphic p. 95).

The third row of any matrix has a fixed referent of $5^2=25$ and any fourth element has a factor of $3^3=27$, and in this example enjoys the numerical value of 25x27=675. This element acts as a numerical bull on the shoulder requiring 60 to be multiplied by 12 into 720 to maintain civilized control over it in the enlarged 720:360 octave-double that divorces Pythagorean meaning from appearances except by coincidences, some of them still mysterious. Thus Inanna's 15 must be moved one place to the right (multiplied into 3x15=45) and then be doubled 4 times (in multiplication by $2^4=16$) through 90, 180, and 360 to frame the model octave now as 720:360 in a way conveniently correlated with the calendar. Notice that the rotated frame of the inverted matrix automatically eliminates all asymmetry in a pattern strangely coincident with an Egyptian cartouche for its Egyptian duplatio arithmetic. (The excluded tritones lie on the long diagonal of a rhomb.) There now are alternate tunings at C:c and E:e differing by syntonic *comma* of 80:81 (at 400:405 and 480:486), so that only 5 different pairs of perfect

symmetry surround the throne—10 mantels of radiance-- mythologized as the delighted Marduk's seat with a back support in his Babylonian temple. (Symmetries to the right and left of D lie on the same pair of laterals.) The cornerstone supplies an asymmetric 12th tone (the Just tritone a-flat) near the middle of the octave in a way that avoids letting its competitor at g-sharp compete with it, and they continue be a main focus of attention.

The brick and music constant of 720 loses only its peak of 625 within the old Sumerian counter for 600 whose limits are shown in figure 11 below, but 600 raises the throne to the third row by its second factor of 5 to present a very different picture. This new alignment preserves one scale in the basic matrix (framed here also as baked bricks) and thus with its inverted reciprocal (not displayed here) - but not both together, and thus forestalling self-contradiction in this pattern. Notice that such rigorous perfect inverse double symmetry (enjoyed by both music and arithmetic) forbids us to declare which pattern rises and which falls. The defined ratios remain the same so that any embodiment becomes our choice and not the gods. But the paired matrices possess in common a rosette center that conceivably symbolized the mysterious Seven Gods associated with astral deities as the only seven values fully shared among 17, and impressed as circles in the damp clay with the rounded end of a stylus. If music actually influenced the mythology and the orthography this result plausibly might have suggested Marduk's later appointment of 600 gods to watch over his new universe in the creation myth of Enuma Elish, as admission of Babylon's old debts to Sumer: three hundred as a guard in the sky; …the same again when he designed the conventions of earth, and made the six hundred dwell in both heaven and earth.[11] But a serious problem is arising. A cornerstone value of $2^9=8^3=8x8x8 =512$ in figures 4 and 5 merely ensures perfection of the unit from which all rational numbers flow, iterating beginning and end in perfect cyclic agreement. But three consecutive steps of 5:4 (dramatized here by the third appearing as 500:400) ensure that the ratio of 5:4 ultimately proves itself a defective cube root. Plato's example rises from cubing 4 and 5 so that 64 leads to 80, then 100, then 125 (*i.e.*, with successive additions of 1/4th); here we see 125:128 as 500:512 directly failing by 3 units after three steps. This diesis that limits musical relevance to the three middle rows might have appeared to any scribe encountering a limit of 3x60=180 within the octave double 180:90, routine in astronomical science. A correction of one part in 125 (as 125+1=126 might have occurred to any alert observer, and it produces a cube root approximation of 1.26 accurate to the fourth decimal place (1.26³=2.000376), with a cumulative excess of less than 1 part in a thousand. We are looking - enroute to the grain-pile - for further evidence

that Sumerian musical cosmology might have been aware of and influenced by such a correlation, accurate enough for modern equal temperament. The prime number 7 governs musicology in very many ways.
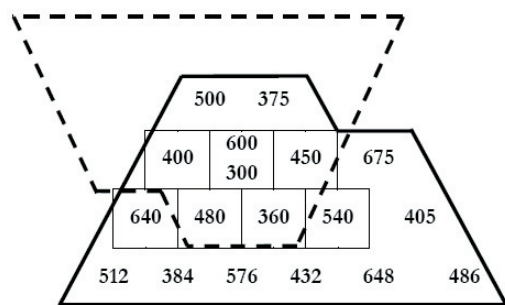

Fig.11. Counter limits 10 x 60 = 600.

Tonal limits of the sar of 60²=3.600

Squaring the basic 60 as if it were literally an equal-sides (in Friberg's effort to English the literal flavour of Sumer's concretized geometrical metaphors) leaves the throne in the third row but the new factor of 3 moves it one place to the right in figure 12 and consequently reveals the pentatonic cartouche modeled in the brick constant of 720 in figure 10 as also its own. Notice, however, that tonal implication must be restricted to only to neighbouring rows immediately above and below the central horizontal axis, enthroned on 225 (as 3.600/16) so that the old cornerstone - moved now to Inanna's original 15 - still lacks a reciprocal that would lie to the right of 3.375 in the fourth row multiplied by 3 into 10.125, well beyond the upper bound here.

Inanna cannot be at odds with herself here however furious she becomes when Gilgamesh curtly rejects her offer of marriage in the epic carrying his name. But notice also that upper and lower rows of the matrix are now excluded from musical rule (because of the diesis in any fourth row). Plato's children of worse births that began to appear in figure 10 within the brick constant of 720, limiting musical interest to only three rows in the matrices of figures 10,11, and 12 lie within a world tree growing taller and sending roots ever deeper (and with the general contour of an hour-glass drum). We imagine these rejected areas to be mythologized in the myth of Etana in which a compact between an eagle and a serpent to help feed each others children eventually is broken by the eagle,
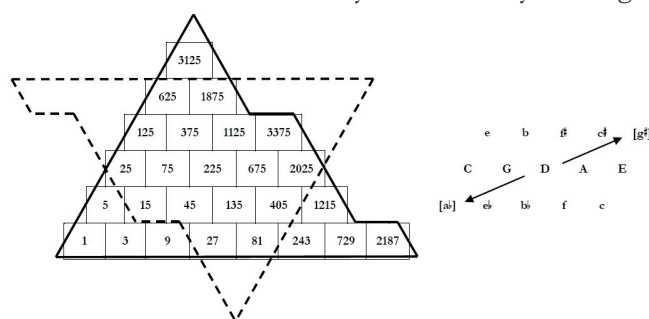

Fig. 12. (See enlarged graphic p. 95).

who gobbles down the serpent's offspring. The inverted peaks (horns) of the sar suggest the locations of the two nests, and with the lower one now empty of the babies we notice in the matrix for 720:360.[12] The main theme of the creation myth of Enuma Elish, as above, so below is displayed here within these inverted matrices. In the very early myth of Etana, twelfth ruler of Kish after the flood, he rescues the eagle, wings clipped and cast into the pit by the revengeful serpent (with the gods approval), and is rewarded by a flight to the heavens, holding on the eagle's breast as they ascend, one, two, three sar in succession, where the eagle shrugs him off to fall to earth, retrieving him on its wings at each mile to make a soft landing.[13]

Uruk and Temple Eanna

Jøran Friberg reads the translations of miles in the Gilgamesh epic as the sar of 3.600 cubits, a near approximation that can be unambiguously decoded as limiting various matrices of possible interest. Setting aside the question of whether it should be, we explore potential meaning. Here is the epic's description of the size of Uruk, with George's restorations and Friberg's sar substituted for miles: [A square sar] is city, [a square sar] date-grove, [a square sar] is clay-pit, half [a square sar] the temple of Inanna; three [square sar] and a half is Uruk's expanse. Now 3½ square sar is 7/2 times the 3.600:1.800 limits of the octave displayed above, but this increase introduces no useable new factors of 3 and 5. Other studies show that 7 is precious in two ways. The ratio of 7:5 (*i.e.*, 7/5) has a gracious tolerance as an acceptable approximation to the square root of 2 [as 1.4 it obviously falls short of 1.41421…] in many contexts. And the ratio 63:50 proves an excellent cube root approximation [63/50=1.26], with only a very trivial excess when cubed to 2.000376, thus accumulating a cyclic error of less than one part in a thousand. At this point we know only that Uruk's Temple Eanna, with a factor of 7, enjoys a tolerant square root and a better cube root. But we still lack the brick values for its symmetric parapret, and they need to be seen in both base 10 and in the reciprocals of regular numbers of base 60 before we can walk the parapet reciprocally (back and forth with Gilgamesh) and testify to its baked bricks. Temple Eanna is only half a square sar, and so we read this speculatively as an upper limit of 3.600/2=1.800 square sar, framing an octave: double of 1.800:900 whose perfect inverse symmetry - if only its baked bricks were identified with the right numbers - would allow us to give positive answers to the purely rhetorical questions Gilgamesh extends to us:

Take the stairway of a bygone era,

draw near to Eanna, seat of Ishtar the goddess,

that no later king could ever copy!

Climb Uruk's wall and walk back and forth!

Survey its foundations, examine the brickwork!

Were its bricks not fired in an oven?

Did the Seven Sages not lay its foundations?

George is translating the standard version of the epic, 'He who saw the Deep', as it survives into the first millennium B.C. in a total of 73 manuscripts from various cities. We display the unfinished temple before anybody can walk its parapet. We can see that perfect inverse symmetry requires them to be reciprocals of the seven in the base as really measured from the middle, where the middle of our favored pentatonic subset is the pentatonic axis of all symmetry (on the coinciding upper and lower limits of 1.800 and 900). The bull of this temple - if it is to enjoy perfect inverse symmetry - obviously is the 7th and last integer in the fifth row, meaning $(3^6=729)x(5^4=625)=455,625$ and multiplication by 7 for the new ratios would send us into the millions. We need a larger counter to achieve that Gilgamesh perspective, and Sumer had one.
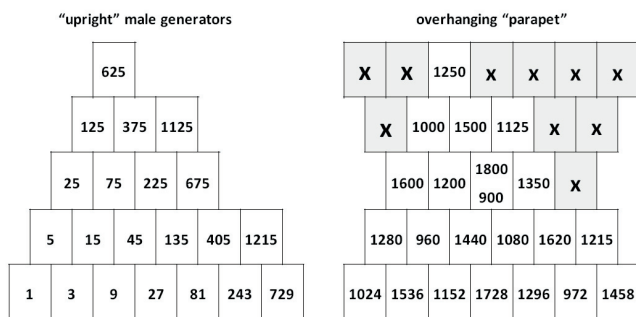
"upright" male generators

		625				
	125	375	1125			
	25	75	225	675		
5	15	45	135	405	1215	
1	3	9	27	81	243	729

overhanging "parapet"

X	X	1250	X	X	X	X
	X	1000	1500	1125	X	X
		1600	1200	1800 / 900	1350	X
	1280	960	1440	1080	1620	1215
1024	1536	1152	1728	1296	972	1458

Fig. 13. Temple Eanna under construction.

The unification of base 10 and base 60 within 36,000

The product of 10x3.600=36.000 further unifies base 10 and base 60 harmonics in a surprising way that probably will be labeled merely a scribal trick by many historians of mathematics (meaning dependent on memory of a chance observation), but it has an established honorable role already in archaeomusicology. Willi Apel explains it succinctly in the first edition of the Harvard Dictionary of Music in his entry on the *comma*, but Hermann Helmholtz developed the argument in more detail already in the 1870s and credited the evidence to the Arabs, citing *Abdul Kadir*, a Persian theorist of the fourteenth century as essentially in agreement with *Al Farabi* in the 10th century and believing it anticipated in Persia in the 3rd to 7th centuries before the advent of Islam. This system of 16 consecutive fifths (*i.e.,* in the same row of the matrix) comes to light in Helmholtz's ratio here in the grain pile.[14] This largest early Sumerian counter exposes a critical set of defining integers that mocks our Greek classification with a knife-edge accuracy irrelevant to an aural art.

The impending impasse perhaps is advertised in Ishtar's sharp toenails. Lay out factors of 3 and 5 to the limit of 36.000 as in its smaller companions, and look for the new convergence, not in the same row, however, but in the two lowest neighboring rows. Figure 14 displays Helmholtz's idea.

The favoured pentatonic cartouche now is enthroned on 9x125=1.125, third value in the fourth row, doubled 5 times into 36.000 (as if multiplied by $2^5=32$, cornerstone value in the 60:30 octave), imagined behind these pitch class names. Base 10 and base 60 have been correlated at each expansion: from 60 to 60^2, then 60^2 to $10x60^2$, and now a third time to $10x3.600 = 36.000$ (at the third increase) when Platonic forms become conversable and rational. For him, as if working from this model, the condition which coming-to-be universally takes place - what is it?
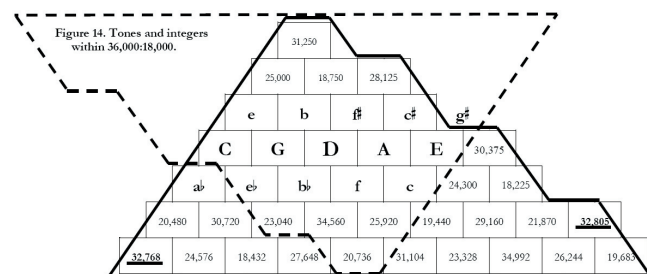

Figure 14. Tones and integers within 36,000:18,000.

Fig. 14. Tones and intergers within 36.000:18.000
(See enlarged graphic at p. 95).

Manifestly 'tis effected whenever its starting point has received increment and so come to its second stage, and from this to the next, and so by three steps acquired perceptibility to percipients.[15]

Here the patience of systematic ordering pays great dividends. The favored family is still free of self-contradiction at the tritone square root of 2 because a^b and $g^\#$ remain in opposing reciprocal matrices, isolated from each other.

Notice, however, among the fully developed integers, doubled for scale order, in the two bottom rows where fresh water is above salt water, that the ninth and last value in the second row agrees with the cornerstone to within one digit in the first three places (*i.e.,* within 1/1000th at 328… to 327…).. In the 1870s Helmholtz computed this Diophantine convergence between Spiral 5ths and its just relative only slightly more accurately as 887:886, but the scribes would have noticed 32.768 by doubling the unit 15 times into 2^15, giving goddess 15 a new validation. At this level of microscopic introspection we cannot tell them apart by ear. We are beyond sensory perception that determines musicality where the cyclic excess in an extended spiral of perfect fifths and fourths converges with the defect of a neighbouring just tuning by ratios of 5:4. We cannot distinguish a^b from $G^\#$ nor $g^\#$ from A^b. The excess of the famous *comma* and the defect in the less familiar just diaschisma are hidden except in the mathematics, historically metaphysical.

Our two systems are disclosed as belonging to a larger embracing unity at a deeper level where extensions of either system overlaps the other. Only an alert scribe would have noticed the numerical convergence, and perhaps only in this particular matrix where the first three digits catch the eye. We have discovered an excellent musical reason for 36.000 as largest useful counter, and perhaps the foundation of Platonic metaphysics, whatever may have influenced the original choice of largest value. The ten elements here in the base justify Pythagorean ten-ness as a reasonable philosophical principle, worth generalizing. The throne in the fourth row, safe from discrepancies of the tritone schisma between the third and fifth rows, is also naturally centered between the dieses of 125:128 in the first and seventh rows. Tonal deity cannot be more comfortably seated in Western harmonic theory. Here is a well rounded pentatonic apotheosis that enjoys extension to a sixth tone in the fourth row as 30.375 introduces pitch class B in spiral 5^{ths} as a sixth member producing the first semitone B:C as Philolaus introduced it to the Greeks in the ratio 256:243 whose defining digits differ by 13. Down through the history of musicology he has been mocked by musicologists for innocently assuming that 13 defines the spiral 5^{ths} semitone: it does, in the model he knew and passed on to Plato.

Now we are ready to look at the grain-pile with some of the double vision that produced Pythagorean science and Platonic dialectics.

The Shuruppak gain-pile
as cultural constant

The matrix for 1.152.000 develops as an extension of all of the earlier ones, enthroned pentatonically as in the limit of 36.000 as largest integer, but extended upward to eleven rows (the hero's height as 11 cubits?) and to the right to its heptatonic tritone at the demonic G-sharp as Ḫumbaba, giant of the cedar forest. The matrix is extended merely by doubling the octave referent (9x125=1.125) ten times (in multiplication by 210=1.024, double the 512 in the World Soul (fig. 7) as another extension of ten-ness. By itself the matrix is an impressive compression of harmonic ratios; read with the insight of the Gilgamesh Epic it displays an awesome literary allegory as a sequence of verbal cartoons of its own numerical content.
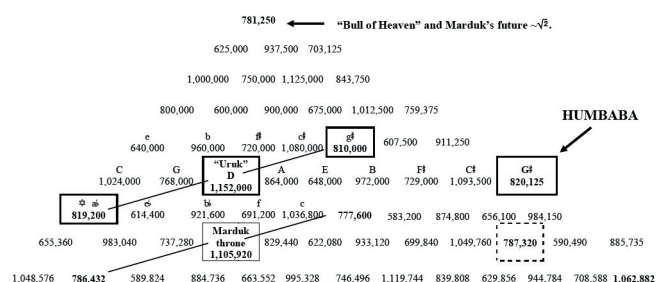

Fig. 15. The grain-pile of 1.152.000 as comprehensive metaphysical speculation (See enlarged graphic at p. 96).

The base of the matrix is formed by the complete spiral of twelve successive musical fifths and fourths but with the 13th pitch class at 312 doubled now for the new correlations above it. Here, we propose, is the Great Serpent as literally Lion of the ground. The cornerstone (1.048.576) is 2^20 and truly another evidence of the sun god Shamash as god 20, doubled from the lower limit of the famous *comma* at 524.288 for present purposes. In a tone circle (see below) the 13 tones in the base become, we suggest, the 13 winds that goddess Wild Cow Ninsun, our hero's mother and best friend to whom he confides his dreams and fears, prays that Shamash will use to protect her boy. The familiar paired just tritones (the diaschisma) from Uruk's D as center of pentatonic symmetry keep D centered in Uruk, now locate the city as a week's journey from the spiral 5^{ths} tritone on G# at the far right that Ḫumbaba allegorizes. Glance at the first three digits of the framed numbers to see that he lies beyond the upper bound of the diaschisma (819…) so that his own paired reciprocal (not shown here, for it lies 12 intervals to his left) necessarily lies below the grain-pile's lower bound. Without it being present (it would extend this matrix four places to the left) we know by inspection that spiral 5^{ths} tritones of 729/512 are superfluous to harmonic models. Gilgamesh and his alter ego Enkidu, now civilized into best friend and protector, travel together in daily ratios of 2:3, so Friberg notices (by ratios of 20:30 distances daily, including a lunch break). They dig a well nightly - whether to pour in a libation to the gods below or merely to replenish their water supply is not indicated - but straight down is water at the undersized semitone ratio of 25:24 below any counter, two rows below, visible between the bricks intruding between them. Marduk's future throne lies 2 rows directly below Uruk and so is similarly surrounded by tritones at the same ratios.

But notice that the bull of the mountain (Enlil on the peak) offers Marduk a better square root than Uruk enjoys. Its first 3 digits, (781…) obviously lie nearer the middle of the Marduk schisma led by 786… and 777…. Up there in the 8th row above Marduk is a better square root of 2 doing nobody any good. Testing it with a reciprocal requires raising the throne to the 8th row so that its reciprocal appears 14 rows below, four rows beneath the present base. This bull of heaven in the grain-pile must be squared into 5^{14}=6.103.515.625 to play the same role in the Marduk matrix, so that his reciprocal can appear as 7th in the new below. Now anyone who sees this possibility can also compute that reciprocal without building a new matrix for it. It will necessarily be defined by 3^6=729 when fighting naked, but to wrestle with the peak must be doubled 23 times (multiplied by 2^{23}=8.388.608 on our pocket calculators) into 6.115.295.232 to show a convergence in the third digits as 610… vs 611… that is of no use to

anyone except to demonstrate digital industry (and perhaps to inspire the successful search for the faster and more accurate convergence published in 1945 by Neugebauer and Sachs. The creation of mankind to produce that enormous matrix is documented descriptively in two Mesopotamian mythologies, and there is evidence for neighboring cultures in India, Egypt and Greece understanding at least a few of the important 10 digit integers within it. And so, in ignorance of what really happened historically, we present that speculated Marduk matrix as if clearly anticipated from the grain-pile, believing that its authors actually intended an ur text in archaeomusicology. The Marduk matrix in figure 16 has been published for several decades, analyzed in detail musically but with less understanding of its position in the history of culture.[17]

Marduk's universal flood at 8.640.000 = $2^{12}\,3^3\,5^7$

The Marduk matrix in figure 16 has been published for several decades, but with less understanding commentary. That the ancient flood is the fault of Gilgamesh is confirmed by the Marduk universe matrix limit of 8.640.000.000 and doubly confirmed by the Bible for his sighting of a better square root at the peak of the Shuruppak grain-pile ensures adding six layers of water below to make them visible to doubting Thomases. The waters prevailed and increased greatly upon the earth; and the ark floated on the face of the waters. And the waters prevailed so mightily upon the earth that all the high mountains under the whole heaven were covered; the waters prevailed above the mountains, covering them fifteen cubits deep (Genesis 7:18-20, reporting the depth in cubits). It also adds 1 triple to the right in rows 2, 5 and 7 that here become rows 8, 11, and 14. Fortunately, this matrix was preserved in Hinduism cosmology to guide our reconstruction here.

Spiral 5ths "naturally" divide the circle into 12 almost equal parts.

Related "Just" major thirds suffer opposite cyclic excess or defect.

"Warfare" in the soul
The two systems, with only three pitch classes in common, converge naturally in opposite ways within the tolerances of most human ears, but not all, at least in all circumstances.
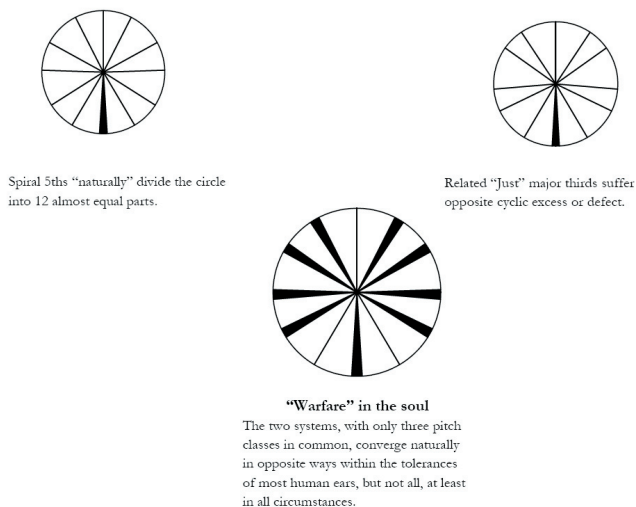
Fig. 16. A musicological overview
(See enlarged graphic at p. 96).

Our story must conclude here with the grain-pile as cosmic constant for eternity in our assumed intention of its authors, and so we correlate the values of the counters in figure 17 with the same central vision.

Figure 18. Harmonic content in 1,152,000 as "grain-pile" limit.
Shamash the sun "sees everything" and favors Gilgamesh with the help of the "13 winds" as divine mother Ninsun asks.

Enlil/Ellil as "Bull" on any peak establishes predictable ratios within triangles, but not shoulders."

AS ABOVE" "

Humbaba as giant

"Earth" as axis of rotation

"SO BELOW"
In an old poem on the death of Gilgamesh he disconsolately builds his own tomb below the diverted Euphrates to reign as a deity only in the Underworld.

13 "Winds" define Spiral Fifths tuning as foundational resource and ground the adventures of the hero. Creative power "rises up" from BELOW / / / … as reported by Berossus but is exercised from ABOVE.
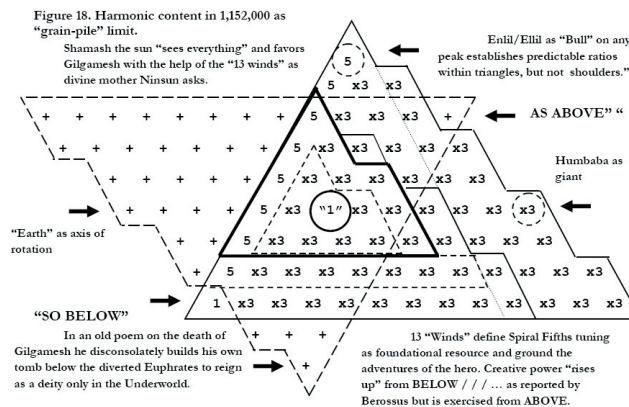
Fig. 17. Harmonic content in 1.152.000 as grain-pile limit.
(See enlarged graphic at p. 97).

Within the grain-pile the completed temple Eanna is defined in base 10 in smallest integers, as if the Gilgamesh Epic was conceived as an accompanying ur text in musicology whose meaning has never been lost in the musical service of the temple, no matter what doctrine is preached from the pulpit. The favoured pentatonic pattern in the middle correlates all of the data in our figures.
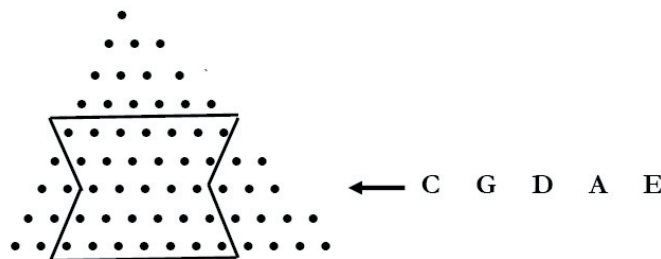

← C G D A E

Fig. 18. Shuruppak grain-pile of 1.152.000
as 65 potential tone numbers.

The Shuruppak grain-pile of 1.152.000 sila of barley is the smallest integer that can define temple Eanna in the baked bricks that Gilgamesh invited us to observe on its parapet, perhaps the model for the eventual hanging gardens of Babylon. The central row is the apotheosis of pentatonic within the just alternate tuning that eventually became YHWH's chosen people. Factors of 7 within 12.600 (=$2^3 3^2 5^2 7$) measuring Uruk and its temple provide an additional ratio of 7:5 as a forgiving square root of 2 without affecting the musical structure. But the factor of a holy 7 also creates a lower third caste of citizens who must be excluded from Platonic rule, while permitting the first four elements of our favored pentatonic priesthood C- G- D- A (or E-A-D-G) to produce a cube root temperament whose numerical definition is more accurate than most aural tuning ever can achieve. Symmetric ratios of 63/50 (=1.26≈1.2599…) as nearly perfect cube root of 2 (i.e., defining equal-tempered major thirds and thus excluding the diesis of 125:128) avoids any

Marduk's universal flood at 8,640,000,000 = $2^{12}3^35$

Peak values of 5^{14} = 6,103,515,625 and its reciprocal (inspired by Gilgamesh's slaying of Humbaba) converge on $\sqrt{2}$. The "throne" is Marduk's "seat with a back support."
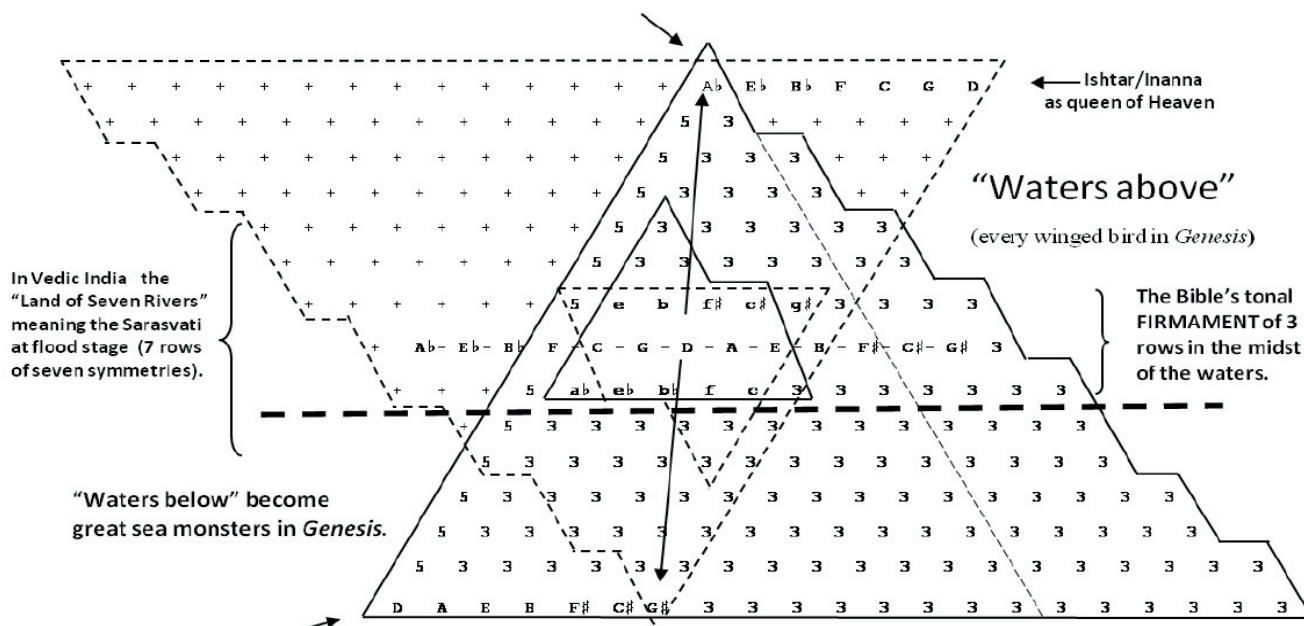
Tiamat, dragon of the deep, and her 20 children form the base. When she is slain the cornerstone of 2^3=8,589,934,592 enthrones Ereshkigal, queen of the Underworld, reciprocal of Ishtar/Inanna, who converge also on the throne (~85:86). The 21 elements both ABOVE and BELOW inspire the 42 judges in the Egyptian Hall of Maat.

Fig. 16

serious accumulations of cyclic error, for the ratio is used only once in each direction from four of the best located pitch classes among the favoured 5. (Cumulative error in cubing 63/50 is less than one part in a thousand, so that proceeding symmetrically from four favoured referents is strategically advisable.) In table 1 C-G-D-A are taken as given, suffering only the slight displacements already present in spiral 5ths tripling (less than 2 cents) in the first pair of twins (G and A at 7 and 5 o'clock) and only 4 cents (one sixth of a *comma*) in the second pair (C and E).

Table 1. The Gilgamesh ratio of 1.26—employed symmetrically as divisor and multiplier of the first four tone values in Spiral 5ths tuning ("Sages from BELOW")-- define a "cube root temperament" within his own city and suggest why he was granted immortality only in the Underworld. Two continuing fractions of .888 and .666 anticipate numerical symbolism of the Savior and the Beast of Revelation in New Testament Christology.

x 63/50	E = 14,112	B =11,529 10584	F#/Gb x ½ = 7,938	C#/Db = 11,907
reference fifths	C = 7 x 1600 11,200	G = 7x1200 8,400	D = 7 x 1800 12,600	A = 7 x 1350 9,450
x 50/63	Ab/G# = 8,888.888…	Eb/D# = 6,666.666…	Bb/A# = 10,000	F = 7,500

Plate1. (See enlarged p. 97).

Logarithmic cents values of 1200 to the octave 2:1 mean that 1200/360 equates 3 and 1/3 cents to a degree so that in this slightly unequal temperament we possess 12 Platonic cyclic boundary markers within

about 1 degree of accuracy for any purpose we please. We appear to be studying music as handmaiden to ancient philosophy and science, via Plato's analysis of ancient mythology.

But a stranger historical correlation is coming into focus before our eyes in the lower row of table 1. Multiplication by reciprocals of 50/63 produces just two continued fractions of 888 and 666 that Christology remembers from early numerical mysticism in the Book of Revelation, treating 666 as in some sense satanic, the number of the beast (Rev 13:18). The A-flat cornerstone of our harmonics is now 8.888.888 and a reminder that--in New Testament Greek - Yeshua, the Savior, a variation on the Old Testament name Joshua, is composed of Greek letter numbers that sum to 888. Who would have expected to find this arithmetic clearly entangled in the proportions of the temple of Eanna dedicated to Inanna in Uruk in the middle of the third millennium B.C.? How deeply did the Sumerians study their own arithmetic?

We must leave questions of the authenticity of this adventure in archaeomusicology to scholars in many disciplines beyond our own. Here we are content to display correlations as we find them, knowing that translators are

still wrestling with monumental problems in the shattered record. Our aim is to awaken new attention to this neglected body of evidence.

Notes

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17 McClain, E.G., *The Pythagorean Plato, Meditations Through The Quran.*
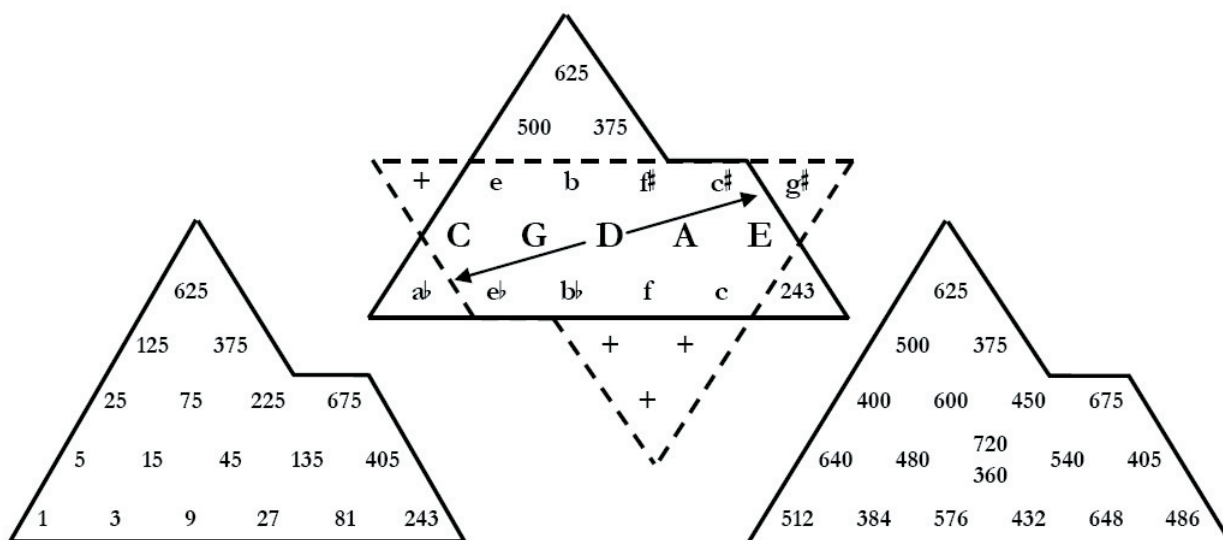
18 McClain, E.G. (1981) *The Myth of Invariance:* 130-7.

Fig. 10. Enlarged.

Fig. 12. Enlarged.

Figure 14. Tones and integers within 36,000:18,000.

Fig. 14. Enlarged.

781,250 ← "Bull of Heaven" and Marduk's future ~√2.

625,000   937,500   703,125

1,000,000   750,000   1,125,000   843,750

800,000   600,000   900,000   675,000   1,012,500   759,375

HUMBABA

| e | b | f# | c# | g# | | |
| 640,000 | 960,000 | 720,000 | 1,080,000 | 810,000 | 607,500 | 911,250 |

| C | G | "Uruk" D | A | E | B | F# | C# | G# |
| 1,024,000 | 768,000 | 1,152,000 | 864,000 | 648,000 | 972,000 | 729,000 | 1,093,500 | 820,125 |

| ✡ ab | eb | bb | f | c | | | | |
| 819,200 | 614,400 | 921,600 | 691,200 | 1,036,800 | 777,600 | 583,200 | 874,800 | 656,100   984,150 |

| 655,360 | 983,040 | 737,280 | Marduk throne 1,105,920 | 829,440 | 622,080 | 933,120 | 699,840 | 1,049,760 | 787,320 | 590,490 | 885,735 |

| 1,048,576 | 786,432 | 589,824 | 884,736 | 663,552 | 995,328 | 746,496 | 1,119,744 | 839,808 | 629,856 | 944,784 | 708,588   1,062,882 |

Fig. 15. Enlarged.

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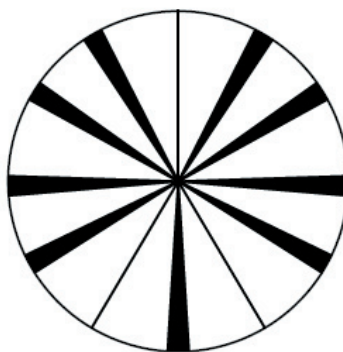
"Warfare" in the soul

The two systems, with only three pitch classes in common, converge naturally in opposite ways within the tolerances of most human ears, but not all, at least in all circumstances.

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Shamash the sun "sees everything" and favors Gilgamesh with the help of the "13 winds" as divine mother Ninsun asks.

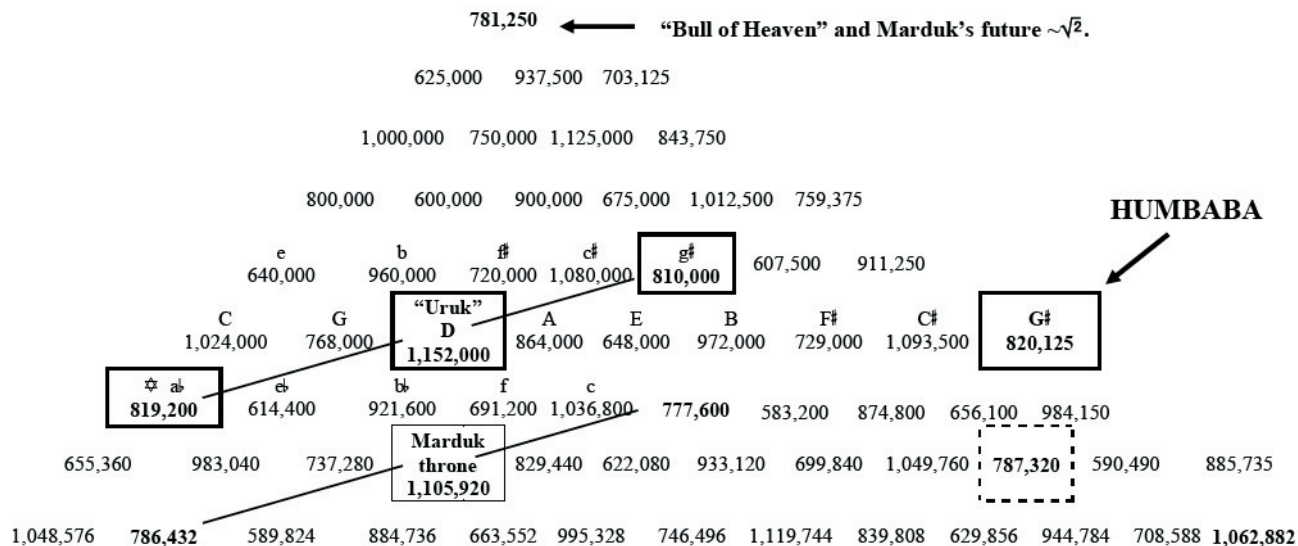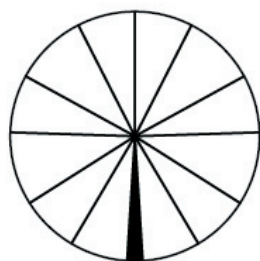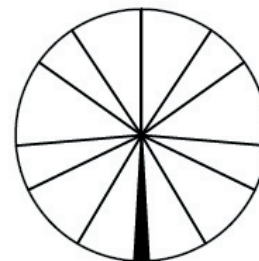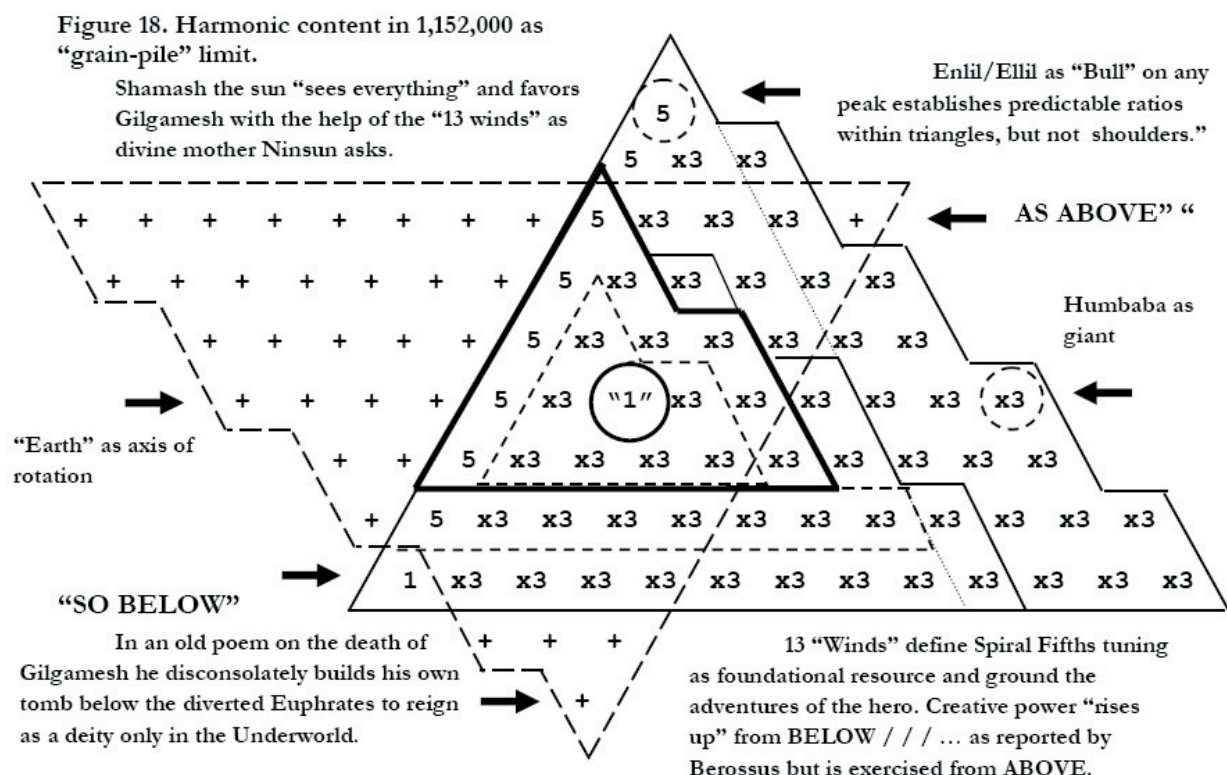Enlil/Ellil as "Bull" on any peak establishes predictable ratios within triangles, but not shoulders."

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In an old poem on the death of Gilgamesh he disconsolately builds his own tomb below the diverted Euphrates to reign as a deity only in the Underworld.

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x 50/63	A♭/G♯ = 8,888.888…	E♭/D# = 6,666.666…	B♭/A♯ = 10,000	F = 7,500

Plate 1. Enlarged.

EVIDENCE AND INFERENCE IN TEXTS OF THEORY IN THE ANCIENT NEAR EAST

Richard Dumbrill

Inference is a mental process by which a conclusion gathered from what is believed to be truthful evidence is reached.

When we look at some evidence from the past, we scrape inference out of it through a thick web woven from our knowledge of the present, which, over the centuries, has been considerably burdened with indiscriminate accumulation of data. Therefore many of our conclusions end up subjective. If we want to be serious with our research, we must forget much of what we know, since this causes obnubilation, until the subtle balance between evidence and inference can be appreciated objectively.

During the past 50 years, self-appointed assyrio-musicologists have published many papers, all with great assyriology, but generally with very poor musicology. Their competence was founded on assyriological repute and as a consequence ancient near eastern musicology became the prerogative of the assyriological elite. There was little comparative ethno-archeomusicology. Assyriologists argued at length about the classification of instruments: was the balağ string or percussion? Organology says both are membranophones. Even major reference works, in print as we speak, perpetuate these misconceptions[1]. This contribution will address the reliability of our perception of the evidence in theory texts and the reliability of the inference that we derive from it.
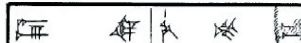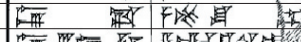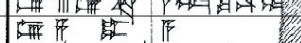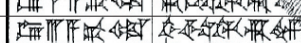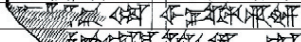
As a secondary introduction, but a most important one, it must be firmly established that music theory is the theoretician's perception of the construction of music systems. Therefore it has nothing to do with the art of music. The study of music in the ancient world and the attempts at reconstructing both its theory and its written music is a legitimate science as long as theory and practice are radically segregated.

Cuneiform theory texts amount to a handful. They are given here in the order in which they contribute to each other's elucidation. UET VII,126[2] and 74[3]; CBS 10996[4] and 1766[5]. There are also fragments of lesser importance which will not be discussed here.

UET VII, 126 = *Nabnitu* XXXII

We shall start with UET VII, 126, because it is essential to the understanding of the other texts in this paper. It is a late Babylonian copy of an older lexical list known as Nabnitu XXXII and therefore the information it contains is the oldest that we have regarding string/pitch names. It is bilingual with the left column in Sumerian the right being its translation into Akkadian. Below is Gurney's hand copy of the Sumerian and Akkadian columns and their transliteration:

Line	Sumerian	Akkadian
1	sa.di	qud-mu-u[m
2	sa.uš[4]	šá-mu-šu-um
3	sa.3.sa.sig	šá-al-šu qa-a[t-nu
4	sa.4.tur	a-ba-nu-[ú
5	sa.di.*5	ḫa-am-[šu
6	sa.4.a.ga.gul	ri-bi úḫ-ri-im
7	sa.3.a.ga.gul	šal-ši úḫ-ri-im
8	sa.2.a.ga.gul	ši-ni úḫ-ri-im
9	[sa.1].a.ga.gul	úḫ-ru-um
10	[9].sa.a	9 pi-it-nu

...and their translation:

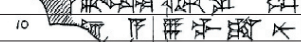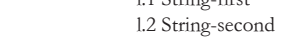| Sumerian	Akkadian
l.1 String-first	front/fore (string)
l.2 String-second	second
l.3 String-three-string-thin	third, thin
l.4 String-four-small	Ea-creator
l.5 String-five	fifth
l.6 String-four of the behind	fourth behind
l.7 String-three of the behind	third behind
l.8 String-two of the behind	second behind
l.9 [String-one] of the behind	one behind
l.10 [Nine] string	nine string

Note that there are nine strings. They amount to an enneachord. There is no evidence of dichotomy in the nomenclature. Therefore the strings were not segregated from the sound they produced. They were one inseparable entity. Had he wanted to suggest dichotomy, the scribe would have made it clear. Therefore the nine strings build up to a system where each of them has its own pitch. Conclusively, this is an enneatonic system.

We have remarked that the Akkadian column is the translation of the Sumerian list. This is inexact with regard the fourth line, which in Sumerian has *string-small-four* while the Akkadian rendition is *Ea-creator*. This is a very important feature which must not be left unexplored. Initially, I thought that the Sumerian number 4 would be the equation to Ea's number of 40. However, this was inconclusive since there is no evidence that Ea was known as 'god four' although he was known as the 'god of 3/4[ths]'. Therefore, it is inferred that the rendition of Sumerian *string-four-small* by Akkadian *Ea-creator* must be a later Akkadian addition, the purpose of which will be explained later when appropriate. There is another problem which appears at line three. There, both languages insist on the adjective *thin*, inferring that this string should be distinguished from its symmetrical counterpart, the *third-string-of-behind*. But thin in what way? The fact is that a thinner string produces a higher pitch and it is thus inferred that this string was placed at the treble part of the instrument. Since there is a treble part, then the bass must be its

opposite. Thus the adjective qualifying the *third-string-of-the-front* as *thin* indicates that it was placed at the treble part of the instrument. This seems incontrovertible. However, it might not be so as we have iconographic occurrences of monumental lyres on which, in the case of the Karnak model[6], there were nine strings. (fig. 1) Two blind-folded musicians play one instrument, facing each other. This suggests that the tuning might have been symmetrical with the bass closest to the players, and sharing a treble string. This would be at the origins of the numbering 1-2-3-4-5-4-3-2-1. The other example comes from İnandık[7] (fig. 2). However, the reliability of the artist's rendition could be questioned because of the size of the instrument.
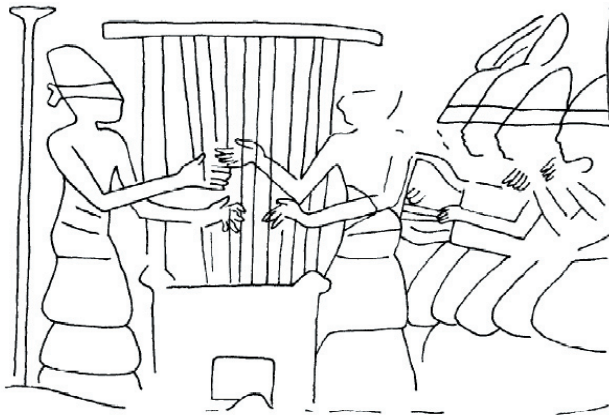

Fig. 1. XVIIIth Dynasty musicians playing a giant lyre. Block from a temple to the Aten at Karnak.
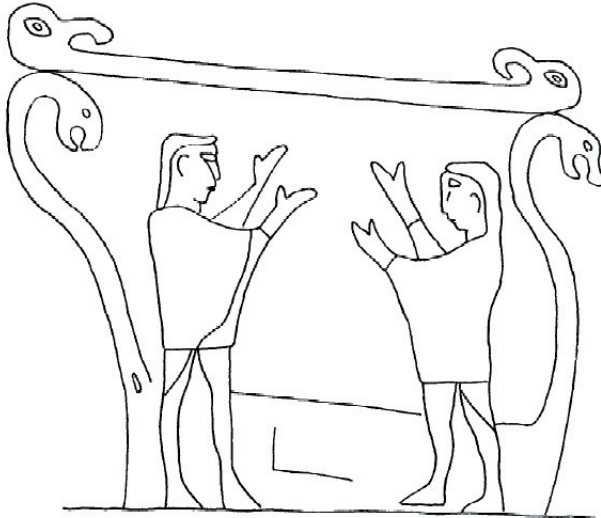

Fig. 2. Hittite. İnandık vase giant lyre. The two characters in front of the instrument might not be its players. However, the size of the instrument, if not borne from some highly imaginative mind, would have needed at least two instrumentists to play it.

The symmetric anhemitonic pentatonic proposition

There is a third problem. Had there been an early type of monumental lyre which was played symmetrically by two musicians, then the most practical tuning arrangement would have been with two

symmetrical anhemitonic pentachords, one ascending the other descending, or the contrary, such as g-a-c-d-e and e-d-c-a-g. The reason is that with this arrangement, whatever the musicians might have played, it would always have sounded right because the absence of semitones makes dissonance impossible[8]. But does this constitute sufficient evidence to build up a conclusive inference? The arguments for the evidence are that a) we have a monumental lyre; b) there are two players of a single instrument. Therefore 1) if the lyre was tuned in a diatonic sytem made up of tones and semitones, this would imply harmony as we understand it today. This proposition must be rejected. 2) If the tuning was an ascending, or descending anhemitonic pentatonic system, then the organology would object because the longest strings are at both extremities of the instrument and the smallest in the middle, making this arrangement impossible. 3) There is always the possibility of an arrangement totally alien to our wildest imagination. But in this case the numbering as we know it would loose its meaning. Therefore we are left with only one possibility satisfying all three previous propositions. This is the anhemitonic symmetric pentatonic arrangement which I have already proposed on grounds that it satisfies the three essential arguments: iconography; theory, and organology. In the light of the evidence, the underlying system could not have been anything else. The inference is therefore conclusive.

The anhemitonic symmetric pentatonic arrangement would have progressed as shown below:
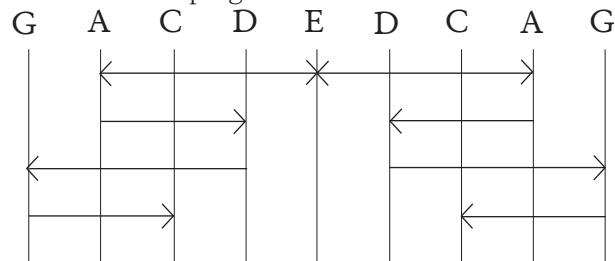
Fig. 3. Anhemitonic symmetric pentatonic arrangement and its tuning sequence as (5-2-4-1-3) from each end of the lyre resulting in g-a-c-d-e-d-c-a-g.

It is probable that this construction was devised in pre-literate times, probably in the course of long evolutionary processes which would have involved the education of the inner ear and its selective appreciation of natural harmonics. It would have been later, in the early days of the written word, that the matter was set to theory. Music composition and improvisation as seen from an ethnomusicological standpoint show that in primitive music there is no scale to which the musician refers since scales are the consequence of theory which in turn is the consequence of literacy. The musician starts with a pitch with which he is comfortable and then ascends or descends on each side of this axis of symmetry. This central pitch would have been the reason for the peculiar numbering in UET VII, 126. Perhaps the

ascending reflected a different mood than the descending, or the contrary. This could well have contributed to the origins of modes.

If the Karnak lyre and the origins of the numbering in UET VII, 126 infer a symmetric pentatonic construction, it is obvious that a non symmetric ascending or descending pentatonic system would have preceded it. The evidence is abundant, especially with lyres of all periods that we see fitted with five strings. The pentatonic construction, ascending or descending, would have been made of fifths and fourths. However, we have no textual evidence for this. The ascending system could have been: C up to G, down to D up to A, down to E = C-D-E-G-A, or whatever, avoiding the tritone. The descending would have followed the same idea.

The diatonic enneatonic mutation

Pentatonism must never be considered as a primitive system, especially in the light of its usage in civilisations that preceded and followed Sumer, and although this is impossible to prove, I would not object to the hypothesis of some form of pentatonic polyphony. However, enneatonic diatonic harmony was inconceivable in in the third millenium B.C. and only sprouted some 4000 years later, in the West.

Whether diatonic enneatonism is a mutation from anhemitonic pentatonism, or a different form altogether is difficult to say. I would postulate that it is both. There would never have been a 'state rule' saying that from day 'x' of the rule of king 'y' pentatonism was banned to the advantage of enneatonism. Pentatonism might have metabolised into diatonic enneatonism, probably as a consequence of its construction, possibly at the dawn of literacy. Why is another matter, but I would hazard the guess that while diatonic enneatonism allowed for modal generation, anhemitonic pentatonism did not, as a consequence of the absence of the semitone, or if it does, it is to a much lesser extent.

The organology of the lyre and the harp allows for the distinction between anhemitonic and diatonic models. With the lyre, the spreading of the strings in a fan-shape across the yoke indicates anhemitonism (fig. 4) while with the harp, it is its arched monostructural form which allows for it. (fig. 5)

The infrastructure of the instruments in figure 4 shows that they were more adapted to anhemitonism, in the case of the harp, on the left, descending anhemitonic and to the right, symmetric anhemitonic. Note that the strings should be counted from the bridge and not from the yoke.

Both instruments in figure 5 show diatonic systems. The lyre to the left, perhaps a diatonic descending enneatonic, and the harp to the right perhaps a double diatonic octatonic system.
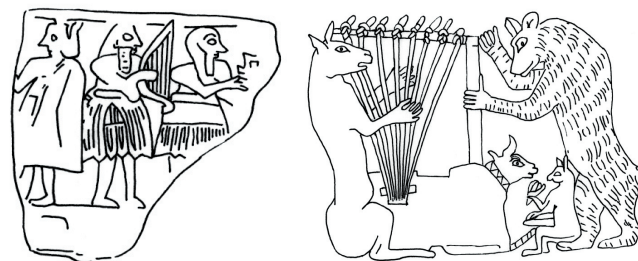
Fig. 4. Anhemitonic instruments.

Fig. 5. Diatonic instruments.

Why should UET VII, 126 describe an enneatonic system although the diatonic heptatonic would have been easily constructed from the extension of the alternation of fifths and fourths method used for the anhemitonic pentatonic, as we have seen above? Indeed, this would have produced a descending b-a-g-f-e-d-c, and an ascending f-g-a-b-c-d-e. The reason could be cosmological and might provide with an explanation as we shall see later.

In 2008 I published a paper in ARANE[9] in which I discussed four tables Hilprecht had published in his twentieth volume of the Babylonian Expedition of the University of Pennsylvania, 1906. The texts came from the temple library of Nippur and dated about 2200 B.C. They were part of some 7000 texts and fragments which he catalogued. The texts were said to be tables of multiplication and division. However, the purpose for these peculiar operations was not fully understood, because the four texts of musical theory which are the object of the present paper had not yet been satisfactorily understood. Thus the purpose for the tables remained obscure. Hilprecht saw similarities with 'Plato's number', as laid out in Republic, Book VIII, but he did not perceive that the missing numbers were the key to the understanding that the texts were about music theory.

In these tables, as judiciously observed, Hilprecht noted that the four tables shared three particular features:
1. The highest number begins the series.
2. The numbers multiplied are not consecutive.
They are often separated from each other by comparatively large intervals. (Note the absence of 7; 11; 13; 14; 17; 19; 21; 22; 23; 26; 28; 29; 31; 33; 34; 35; 37; 38; 39; 41; 42; 43; 44; 46; 47; 49; 51; 52; 53; 55; 56; 57; 58; 59; 61; 62; 63; 65; 66; 67; 68; 69; 70; 71; 73; 74; 75; 76; 77; 78 and 79.)

Out of 81 numbers, only 30 are listed.

3. Besides 3 and 5, no indivisible number or its multiple is multiplied.

Now, let us go back to the construction of enneatonism as it is described in UET VII, 126.
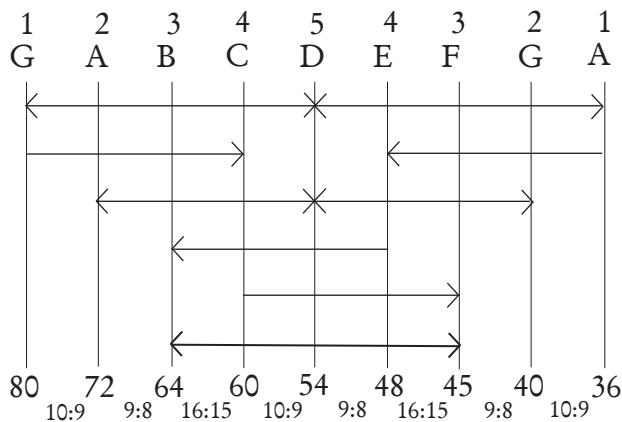
Fig. 6. Enneatonic construction in UET VII, 126 with tone numbers and ratios between them.

Figure 6 above is the graphic construction of UET VII, 126. The method consists in projecting two fifths from each side of the axis of symmetry: D, down to G and D, up to A. From there, fourths are projected toward the axis: G, up to C and A, down to E. Then two fourths are projected from the axis: D, down to A and D up to G. Then two fourths are projected from the end of the second sequence of the construction: C, up to F, and E down to B. The interval between their extremes amounts to a tritone. The construction might have varied in its order, as well as in its direction. The scale could have been either G-A-B-C-D-E-F-G-A, or A-G-F-E-D-C-B-A-G, to the exclusion of any other.

This system predated the typical heptatonic construction which consists, as we all know, in the alternation of fifths and fourths to produce either a desending scale of b-a-g-f-e-d-c, or an ascending one of f-g-a-b-c-d-e. But why was this simpler heptatonic construction not adopted earlier? Now, having examined the enneatonic construction in UET VII, 126, it is time to go back to the Nippur texts.

The Pythagorean right-angled triangle has sides which measure 3, 4 and 5. Therefore they have 3:4:5 as ratios between them. The ratio of 5:6 is made up from the doubling of side 3 in relation to the hypotenuse. Ratios of 1:2 and 2:3 arise from the halving of 4. Thus we have 1:2; 2:3; 3:4; 4:5 and 5:6. These ratios correspond to the first divisors in the Nippur tables. However, the divisor '1' should relate to 12.960.000[15], and not to 8.640.000 whose divisor should be $1^{1/2}$. Hilprecht was concerned by this discrepancy and writes: *I am unable to explain this strange phenomenon. Possibly we have to regard it as an abbreviated expression well understood by the Babylonians*. I do not see, either, any reason for this other than an irrational one, or, as Crickmore puts it to me, in a recent communication:

'...could line one, for example, be a concession to practical musicians, who are not generally noted for their mathematical expertise? Or, could it be a reminder for theoretical musicians that the whole of these tables can have an application in a musical context? Or is it simply the scribe's dedication of the table to Ea, the god of music?'

Indeed, if we read the sign šuššu, = 60, Anu's number, referring to the musical string of 60 ubānatu, then 60 x 2/3 = 40, which is Ea's number. As we have seen, UET VII, 126 shows that in l.4 a fourth-string is listed, bilingually, as Sumerian 'sa.4.tur' = *string four small*, and Akkadian a-ba-nu-[ú] = *Ea-creator*. It is the only string with a possible godly relationship mentioned in the text. The pairing of Ea with this fourth string while the god is usually associated with number 40 attracted my attention. Might there have been an earlier numbering of the gods where only the leading deities were listed as: 6 for Anu; 5 for Enlil; 4 for Ea; 3 for Sin and 2 for Šamaš, while they are usually known as 60; 50; 40; 30 and 20, respectively? The ratios between them would be: 6:5; 5:4; 4:3; and 3:2. In the sexagesimal musical scale, the ratio of 6:5 is the minor third; the ratio of 5:4 is the major third; 4:3 is the fourth and 3:2 the fifth. These constitute the essential intervals of the Babylonian musical system, as we shall see later with CBS 10996.

As shown above, UET VII, 126 lists strings in a particular manner which explains a construction method devised for an enneatonic system, predecessor of the heptatonic model, if not its forerunner. It follows that the range of divisors resulting from this method is placed between the Nippur numbers 36 and 80: 36; 40; 45; 48; 54; 60; 64; 72; 80.

Not only are all of these numbers divisors in Hilprecht's reconstruction of the Nippur texts, but the missing numbers in his table are also absent from the pattern in UET VII, 126. It is obvious that this cannot be purely coincidental. Significantly, UET VII, 126 has 80 as its highest number. The smallest interval produced by the divisors also ends Hilprecht's reconstruction, with the ratio of 80:81. This is the syntonic *comma* also known as th Ptolemaic *comma* or *comma* of Didymus, and measures 22 cents.

It follows that enneatonism was acceptable within the Sumerian cosmology because 9 is a regular number whilst 7, 11 and 13 are not.

Coincidently, Leon Crickmore has recently sent me four short research papers for publication with ARANE[12]. The fourth could well give the evidence for the metaphorical perpetuation of enneatonism with Hesiod's muses in Theogony, 77-9: 'I strongly suspect that Plato may have conceived the nine Muses, whom, in this passage, he has chosen to speak on his behalf, as hypostasized factors of his 'sovereign geometrical number' (60^4). The three basic numbers of the 'two harmonies' are all present (2700

: 3600 : 4800). 3600, the number of Terpsichore, Muse of chorus and dancing, serves as the geometric mean not only between 2700, Euterpe, Muse of music, and 4800, Urania, Muse of astronomy – the 'two sister sciences' (Republic, 530d) - but also between the other three palindromic pairs: (1-9, 3-7 and 4-6). The evidence for adopting a palindromic approach lies in the cuneiform tablet UET VII, 126, [...] as follows: 1, 2, 3, 4, 5, 4, 3, 2, 1, adding the appropriate Babylonian string-names. [The table below] displays these, together with the comparable Greek nomenclature. The ratios between the tone-numbers are strictly palindromic with regard to the placing of the tones and semitones, although to preserve integers the major and minor tones (9:8 and 10:9) have sometimes been exchanged. The underlined numbers indicate tone-numbers which have been increased by a syntonic *comma* (81:80) for Pythagorean tuning. If these speculations have any truth in them, then, contrary to the currently received opinion, the arithmetic of just tuning, as used in Babylonian times, must have been familiar to Plato and to his audience.'

There are still many scholars who dismiss the enneatonic proposition. Mainly, their view is that UET VII, 126 is an enneachord, with the meaning of *'an instrument fitted with nine strings'* and not of *'a system of nine notes'*, or an enneatonic system, and that in spite of the evidence, they have the misguided perception that heptatonism lies within the enneachord. This is flawed because these systems are not related. They are also misguided in their view that enneatonism had no parallels. Aristoxenus, quoted by West[12], mentions the *enneachordon* as a foreign instrument [from the Levant] which was obsolete in the days of Apollodorus. West adds that it might have been a harp, but could not say why it was distinguished from others by a special name, but I contend that it was because it was enneatonic.

The Jesuit polymath Athanasius Kircher[13](1602-1680), writing during the Renaissance, perpetuates the enneatonic concept in his *Enneachord of Nature* which is founded in the Hermetic doctrine of correspondences envisioned as an instrument on which each of the nine strings resounds through all the levels of being in the universe, in good Hesiodian spirit.

The late Archimandrite Antoine Herby[14], quoting Chrysanthus, writes that Byzantine music has two scales, the first, enneatonic and made up of two conjunct diatonic pentachords, and the second, octatonic, composed of two disjunct diatonic tetrachords. In the early nineteeth century, the Θεωριτικὸν μέγα had become the official rule for Byzantine chant. Thus the enneatonic tradition has survived to our days, hidden away by the easier practice of heptatonism, devoid of the Sumerian metaphor.

UET VII, 74

Earlier, we have discussed the reason for having the pre-positioned adjective 'thin' at the third string of the front. Now we shall explore the reason why the Akkadian theoreticians further qualified the fourth string of the front with Ea's godly intervention. This, however, needs elucidation from the next text, UET VII, 74.

For over thirty years this tablet has been wrongly qualified as a text of tuning instructions, or as a retuning text. It is neither because the instructions given do not allow for *tuning* anything in any way. According to Gurney, the instructions take it that the instrument has already

Name of strings	Front		Next		Third thin		Fourth small		Fifth		Fourth behind		Third behind		Second behind		Behind
String numbers	1		2		3		4		5		4		3		2		1
Hypothetical pitches	a'		g'		f'		e'		d'		c'		b		a		g
Tone numbers	36		40		45		48		54		60		64		72		80
Ratios Intervals		10:9 t		9:8 t	16:15 s			9:8 t		10:9 t		16:15 s		9:8 t		10:9 t	*
Greek system	576		<u>648</u>		<u>729</u>		768		864		<u>972</u>		1024		1152		1296
(x16 = 2⁴)		9:8		9:8	256:243			9:8		9:8		256:243		9:8		9:8	**
Greek string names	Nete		Para nete		Trite		Nete		Para nete		Trite		Para mese		MESE		li-chanos

Hyperboleion — Diezeugmenon — Diazeugsis (Disjunction) — Meson

Fig. 7. Crickmore's comparative table.

* *pītum* heptachord. Just tuning. Numbers based on mathematical tables.

** Hypodorian octave species. Pythagorean tuning. Numbers underlined differ by a syntonic *comma* (x81:80).

been tuned in the scale of *išartum* and then, how to generate seven modes from it.
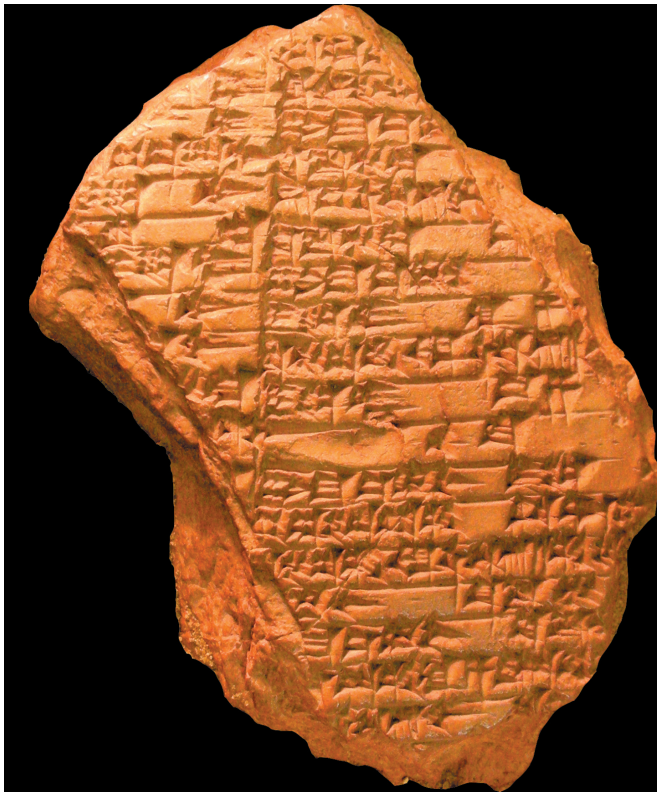
0 *[šum-ma* ᵍⁱˢZÀ.MÍ *pi-i-tum-ma]*
1 *[e-e]m-b[u-bu-um la za-ku]*
2 *ša-al-š[a-am qa-at-na-am tu-na-sà-aḫ-ma]*
3 *e-em bu-bu-u[m iz-za-ku]*
4 *šum-ma* ᵍⁱˢ*Z]À.MÍ e-em-bu-bu-um-ma]*
5 *ki-it-mu-um [la za-ku]*
6 *re-bi úḫ-ri-im [tu-na-sà-aḫ-ma]*
7 *ki-it-mu-um i[z-za-ku]*
8 *šum-ma* ᵍⁱˢZÀ.MÍ *k[i-it-mu-um-ma]*
9 *i-šar-tum la za-[ka-at]*
10 *ša-mu-ša-am ù-úḫ-ri-a-a[m tu-na-sà-aḫ-ma]*
11 *i-šar-tum iz-za-[ku]*
12 *nu-su-ḫ[u-um]*
13 *šum-ma* ᵍⁱˢZÀ.MÍ *i-šar-t[um-ma]*
14 *qa-ab-li-ta-am ta-al-pu-[ut]*
15 *ša-mu-ša-am ù-úḫ-ri-a-am te-[ni-e-ma]*
16 *[*ᵍⁱˢ*]ZÀ.MÍ ki-it-mu-[um]*
17 *[šum]-ma* ᵍⁱˢZÀ.MÍ *ki-it-m[u-um-ma]*
18 *[i-ša]r-ta-am la za-ku-ta-am t[a-al-pu-ut]*
19 *[re-bi] úḫ-ri-im te-ni-e![-ma]*
20 *[*ᵍⁱˢZÀ.MÍ *e-em-bu-bu-um]*

Fig. 8. Author's photograph and Gurney's transliteration.

If the harp is tuned in the scale of *išartum*
the tritone placed between degrees 5 and 2 is *qablītum*
tune up by a semitone degree 5
then the harp will be tuned in the scale of *qablītum*

If the harp is tuned in the scale of *qablītum*
the tritone placed between degrees 1 and 5 is *nīš tuḫrim*
tune up by a semitone degrees 1 and 8
then the harp will be tuned in the scale of *nīš tuḫrim*

If the harp is tuned in the scale of *nīš tuḫrim*
the tritone placed between degrees 4 and 1 is *nīd qablim*
tune up by a semitone degree 4
then the harp will be tuned in the scale of *nīd qablim*

If the harp is tuned in the scale of *nīd qablim*
the tritone placed between degrees 7 and 4 is *pītum*
tune up by a semitone degree 7
then the harp will be tuned in the scale of *pītum*

If the harp is tuned in the scale of *pītum*
the tritone placed between degrees 3 and 7 is *embūbum*
tune up by a semitone degree 3
then the harp will be tuned in the scale of *embūbum*

If the harp is tuned in the scale of *embūbum*
the tritone placed between degrees 6 and 3 is *kitmum*
tune up by a semitone degree 6
then the harp will be tuned in the scale of *kitmum*

If the harp is tuned in the scale of *kitmum*
the tritone placed between degrees 2 and 6 is *išartum*
tune up by a semitone degree 2 and 9
then the harp will be tuned in the scale of *išartum*

If the harp is tuned in the scale of *išartum*
the tritone placed between degrees 5 and 2 is *qablītum*
tune down by a semitone degrees 2 and 9
then the harp will be tuned in the scale of *kitmum*

If the harp is tuned in the scale of *kitmum*
the tritone placed between degrees 2 and 6 is *išartum*
tune down by a semitone degree 6
then the harp will be tuned in the scale of *embūbum*

If the harp is tuned in the scale of *embūbum*
the tritone placed between degrees 6 and 3 is *kitmum*
tune down by a semitone degree 3
then the harp will be tuned in the scale of *pītum*

If the harp is tuned in the scale of *pītum*
the tritone placed between degrees 3 and 7 is *embūbum*
tune down by a semitone degree 7
then the harp will be tuned in the scale of *nīd qablim*

If the harp is tuned in the scale of *nīd qablim*
the tritone placed between degrees 7 and 4 is *pītum*
tune down by a semitone degree 4
then the harp will be tuned in the scale of *nīš tuḫrim*

If the harp is tuned in the scale of *nīš tuḫrim*
the tritone placed between degrees 4 and 1 is *nīd qablim*
tune down by a semitone degrees 1 and 8
then the harp will be tuned in the scale of *qablītum*

If the harp is tuned in the scale of *qablītum*
the tritone placed between degrees 1 and 5 is *nīš tuḫrim*
tune down by a semitone degree 5

Fig. 9. This translation is the result of a reconstruction by extrapolation of what would have been the original text. I shall dispute this later.

The interpretation of the instructions above in the reconstructed translation are clear. They seem to present no ambiguity and appear to offer no other alternatives to Gurney's version of 1994, who, however, insisted that this expressed Pythagorean heptatonism whilst I considered it was sexagesimal enneatonism. We had endless discussions and many mails were exchanged but the Oxford scholar had never heard of sexagesimal enneatonism - only Pythagorean heptatonism. We never agreed and consequently many papers I have written in the past were rejected for that reason.

However, the translation into music of UET VII, 74, above, is inaccurate because it is given in the equal temperament system where semitones measure 100 cents. The units of string length for *išartum* would be 60 64 72 80 90

Fig. 10. Musical transcription of Gurney's interpretation of the text.

96 108 120 128 with ratios between them of 15:16; 9:8; 10:9; 9:8; 16:15; 9:8; 10:9; 16:15, and cent values of 111.73; 203.91; 182.40; 203.91; 111.73; 203.91; 182.40; 111.73. These figures appear approximate because they are given in the decimal but they equate to regular sexagesimal numbers. The evidence in UET VII, 74 conclusively proves that the system is sexagesimal and not Pythagorean. There is futher conclusive evidence that the system is enneatonic since its modes have nine notes each, no more and no less and had the scribe intended to suggest heptatonism, he would have given instructions to that effect. The instructions are simple. On a given scale, the tritone is located, *i.e.* between strings x and y. Tune up string x or y by a quantity which must be a semitone, as nothing else would do. Once this is done, a new mode is generated. The scales which result from this construction are modes, a mode being a manner to be of a scale. From a particular arrangement of its degrees, a mode is a variation on the generic scale.

Now enneatonism differs from heptatonism in that the former arises from a symmetrical construction of its degrees and the latter from a construction which consists in the alternation of fifths and fourths. In both cases the sequence would end when the ultimate of its intervals would be a tritone, and, therefore, it ends at the penultimate to avoid this. This is a consequence of diatonic construction. Enneatonism and heptatonism are therefore a consequence of their respective methods of construction. The enneatonic scale is palindromic with

regard the value of its intervals: g-a-b-c-d-e-f-g-a, and the heptatonic scale is either ascending f-g-a-b-c-d-e, or descending b-a-g-f-e-d-c, depending on it being rising or falling.

It could be argued that the enneachord is a heptachord with its first and second degrees repeated at the octave. However, we have already said that the octave would have been difficult to perceive because it has the same harmonics as the fundamental from which it arises. Thus the eighth and ninth degrees are not the octaves of the first and the second. They have, on the other hand, interval relationships of thirds, fourths, fifths and sixths between them, as text CBS 10996 clearly explains. In practice, the octavial jump would have been inconceivable, as it was for many centuries. Composers have mainly used this interval as a tool to increase the volume of a pitch rather than for its qualities as an interval. The octave ratio does not consitue harmony as it is a homophonic ratio. All other ratios have harmonical relationships with each other, whether consonant or dissonant. There is no known term for the octave and I think it should not be, at least in archaeomusicology considered as an interval, but simply as the doubling of a pitch.

It is now appropriate to discuss the peculiarities of the third and fourth strings. We have sufficient evidence that the qualification of the third string amounts to a locative as it places the note in relation to the scale. In the enneatonic construction of UET VII, 126, the diagram in figure 6 shows that the system ends at the tritone f-b. Now b is located on the third thin string, the text instructs that it should be raised to up to c, the pitch of the fourth string, the string created, or corrected by Ea. The tritone is corrected to consonance. I do not think that the instructions could have been clearer and amount to conclusive inference.

However, there is another problem with which we are confronted. Why, in this case, should we presume that the sequence, as reconstructed by Gurney, should start with *išartum* (c-b-a-g-f-e-d-c-b) whilst it should be with *pītum* (a-g-f-e-d-c-b-a-g), as it is the generative enneatonic scale. As we have said before, any modal construction must start with the tuning of a generative scale from which to progress. During the Old-Babylonian period the evidence is that it was the enneatonic model which was used.

From the premise that the 12th line divides the text into two symmetric sequences, Gurney derived that at the end of the second cycle there would probably have been a rubric corresponding to the *nussuḫum* of line 12, either a form of *nê'um* or, as suggested by Theo Krispijn, of the verb *saḫāpu* to lower (Sumerian šú or šú-šú), and that on this basis the text would have started and ended with *išartum*. But there is absolutely no evidence for this. The text starts, in its actual state, with the first quatrain of *pītum*, although, line 0 is reconstructed. There is no evidence that there

were any lines before, or had there been, that they were as reconstructed by Gurney. It is therefore reasonable to assume, in the light of UET VII, 126, that the text started and ended with *pītum* since this is the generative scale. Furthermore, this might elucidate the meaning of *pītum*, 'opening', since this is with this mode that the modal sequence would have started. Other terms such as *embūbum* 'reed-pipe', might also find their meaning, perhaps: 'pitch pipe', the pipe which gave the generative pitch; *kitmum*, 'closing' also finds its meaning as it ends the quatrain with *išartum* and therefore 'closes' the sequence; and also the meaning of *išartum* 'normal', or 'erect' which is suggestive of its qualities, since its 'tonic' is now raised, or erected by a semitone, because of the instructions. The conjectutal modes of *nīd qablim, nīš tuḫrum* and *qablītum,* might have been some form of 'plagal' modes in relation of the 'authentics'. In Greece, the plagal modes were distinguised in name by the prefix 'hypo', hence, authentic Dorian and plagal Hypodorian. This might explain *siḫip* in N 4782 and N 3354, as in *siḫip išartum*, for instance. UET VII, 74 might have had four 'authentic' modes: *pītum, embūbum, kitmum* and *išartum*, and four 'plagal' modes: *išartum, qablītum, nīš tuḫrum* and *nīd qablim.*

I contend that there is no evidence that there were more than four modes, at least during the enneatonic period. The seven modes - or eight with the ocave - that we know from later sources, would be the consequence of heptatonism. It is therefore axiomatic that these modes could only be the consequence of a system enabling their construction. Prior to the generation of these modes, there would have been no reason for anyone to think otherwise. Gurney and others have assumed that there were seven modes only because either they never envisaged an anteceding system and, or, because extrapolation mislead them into this assumption.

Additionally, should we take the meaning of 'mode' in the modern sense, then each of the Old Babylonian paradigms would be made up of two octatonic or three heptatonic modes: enneatonic a-g-f-e-d-c-b-a-g, has octatonic a-g-f-e-d-c-g-a and g-f-e-d-c-b-a-g, and heptatonic a-g-f-e-d-c-b; g-f-e-d-c-b-a and f-e-d-c-b-a-g. Then which one to choose? Would the series a-s-f-e-d-c-b-a-g be descending octatonic mode of 'a' or 'g'; or heptatonic descending mode of 'a', 'g', or 'f'?

Cannot my distinguished colleagues who oppose my thesis realise that they cannot have it both ways: why should there be 7 modes noted down while 4 suffice to generate the whole of the 7 heptatonic modes? Their assurance that 7 were listed is a contradiction to their heptatonic standpoint since it would appear to promote enneatonism.

Thus the reconstruction of the text should be:

If the harp is in pītum (mode)
embūbum (interval) is unclear (tritone)
tune up string 3
embūbum (interval) is clear

If the harp is in embūbum (mode)
kitmum (interval) in unclear (tritone)
tune up string 6
kitmum (interval) is clear

If the harp is in kitmum (mode)
išartum (interval) is unclear
tune up string 2 and 9
išartum (interval) is clear

If the harp is in išartum (mode)
qablītum (interval) is unclear
tune down string 2 and 9
kitmum (interval) is clear

If the harp is in kitmum (mode)
išartum (interval) is unclear
tune down string 6
embūbum (interval) is clear

If the harp is in embūbum (mode)
kitmum (interval) is unclear
tune down string 3
pītum (interval) is clear

Therefore, we have:

Dynamic	Thetic
a-g-f-e-d-c-b-a-g	a-g-f-e-d-c-b-a-g
d-c-b-a-g-f-e-d-c	a-g-f$^\#$-e-d-c-b-a-g
g-f-e-d-c-b-a-g-f	a-g-f$^\#$-e-d-c$^\#$-b-a-g
c-b-a-g-f-e-d-c-b	a-g$^\#$-f$^\#$-e-d-c$^\#$-b-a-g$^\#$
g-f-e-d-c-b-a-g-f	a-g-f$^\#$-e-d-c$^\#$-b-a-g
d-c-b-a-g-f-e-d-c	a-g-f$^\#$-e-d-c-b-a-g
a-g-f-e-d-c-b-a-g	a-g-f-e-d-c-b-a-g

To conclude, I have exposed here a typical example of how one can be misled in extrapolating inference from evidence, and from which, subjectively, one can reconstruct theory. We must never assume that our atavistic methodology is reliable, since this amounts to a regression from a logical and intellectual mental function, to an archaic level of mental function in which the procedure of suggestion has subjectively determined our acceptance of flawed concepts.

CBS 10996

The next tablet was wrongly said to be a tuning text, and again, I will maintain that nothing can be tuned from it because it has no instructions to that effect. It is a list of intervals of rising or falling fifths and thirds.

Fig. 11. Photograph of CBS 10996, Col. 1.

[a. 1 - 5		SA *niš tuḫrum*
[b. 7- 5		SA *šeru*
[c. 2 - 6		SA *išartu*
[d. 1 - 6		SA *šalšatu*
[1. 3 - 7		SA *embūbu*
[2. 2 - 7		SA *rebūtu*
[3. 4 - 1		SA *nīd qabli*
[4. 1 - 3		SA *isqu*
[5. 5 - 2		SA *qablītu*
6. 2 - 4		SA *titur qablītu*
7. 6 - 3		SA *kitmu*
8. 3 - 5		SA *titur išartu*
9. 7 - 4		SA *pītu*
10. 4 - 6		SA *serdû*
11. SA *qudmū*	*ù* SA 5-*šú*	1 - 5 SA *niš tuḫrum*
12. SA *uḫri*	*ù* SA 5-*šú*	7 - 5 SA *šeru*
13. SA *ša*-GE₆	*ù* SA 4 *uḫri*	2 - 6 SA *išartu*
14. SA *qudmū*	*ù* SA 4 *uḫri*	1 - 6 SA *šalšatu*
15. SA 3-*šú* SIG	*ù* SA 3-*šu uḫri*	3 - 7 SA *embūbu*
16. SA *ša*-GE₆	*ù* SA 3-*šu uḫri*	2 - 7 SA *rebūtu*
17. SA ᵈÉ-a-DÙ	*ù* SA *qudmū*	4 - 1 SA *nīd qabli*
18. SA *qudmū*	*ù* SA 3-*šú*-SIG	1 - 3 SA *isqu*
19. SA 5-*šú*	*ù* SA *ša*-GE₆	5 - 2 SA *qablītu*
20. [reconstructed with the same pattern]		2 - 4 *titur qablītu*
21.		6 - 3 *kitmu*
22.		3 - 5 *titur išartu*
23.		7 - 4 *pitu*
24.		4 - 6 *serdû*

Fig. 12. Kilmer's transliteration of lines 11-24.

The text is explicitly divided into two sections. The first starting at reconstructed line a. and ending at line 10; the second starting at line 11 to end with line 24. We shall rename the lines with line a. = 1. Thus we have now 28 lines. The first 14 have the following pattern:

1	1-5	*nīš tuḫrum*	rise of the equivalent
2	7-5	*šēru*	song
3	2-6	*išartu*	normal, erect
4	1-6	*šalšatu*	third
5	3-7	*embūbu*	reed-pipe
6	2-7	*rebūtu*	fourth
7	4-1	*nīd qabli*	fall of the middle
8	1-3	*isqu*	lot/portion
9	5-2	*qablītu*	middle
10	2-4	*titur qablītu*	bridge of the middle
11	6-3	*kitmu*	closing
12	3-5	*titur išartu*	bridge of the normal
13	7-4	*pītu*	opening
14	4-6	*serdû*	lament

and the second:

15	string 1 of front and string five	= *nīš tuḫrum*
16	string 3 of behind and string 5	= *šēru*
17	string 2 of front and string 4 of behind	= *išartu*, etc.

This immediately shows that two systems of 14 intervals are listed there. Firstly from lines 1 to 14, an heptatonic listing where intervals are restricted to a span of the seven pitches of the heptatonic paradigm, *i.e.*, 1-2-3-4-5-6-7; and the second where the intervals are also restricted to the heptatonic but this times where the strings are named with their enneatonic denomination, *i.e.*, 1ˢᵗ-of the front, 2ⁿᵈ-of the front, 3ʳᵈ-thin, 4-Ea-creator, five, 4ᵗᶠ-of behind, and lastly 3ʳᵈ-of behind, which in the heptatonic is the last note which equates to heptatonic 7. The intervals are of two types, either fifths or thirds, of which we cannot say if they are either rising or falling.

The sequence of the numbers is broken. If it is reconstructed, it will produce a series spanning a triskaidecachord: 1-5/7-5/2-6/8-6/3-7/9-7/4-8/10-8/5-9/11-9/6-10/12-10/7-11/13-11.

The 13 degrees immediately suggest that the triskaidecachord consists of two conjunct heptachords. This would be in keeping with the construction in UET VII, 126. The pitch of conjunction is 'd'. The reason is that it is the only possible arrangement if one is to avoid bumping into the tritone before the end of the sequence. Here the tritone concludes the sequence, as expected. Therefore it is conclusive evidence that CBS 10996 responded to the ancient system in UET VII, 126.

Furthermore, this implies that heptatonism would have been a consequence of a symmetric construction and that its own construction, consisting in the alternation of fifths and fourths would also have been a consequence of the triskaidecachord. Therefore, CBS 10997 is a most important text because it expresses the transition between the old and the new systems.

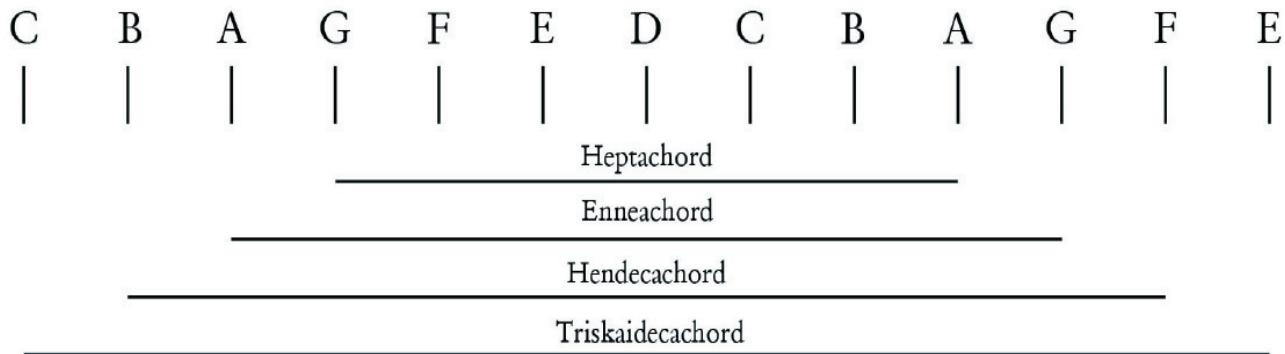| C	B	A	G	F	E	D	C	B	A	G	F	E
|	|	|	|	|	|	|	|	|	|	|	|	|

Heptachord
Enneachord
Hendecachord
Triskaidecachord

Fig. 13. Hepta-, ennea- and triskaideca- chords, in symmetry from central axis of D.

Although we have evidence of heptatonism in this text, it must be remembered that the numbering of the strings is given both in the heptatonic order, reconstructed lines 1 to 14 (1-2-3-4-5-6-7) and that from lines 15 to 28 it is the old palindromic enneatonic numbering which is given, as we knew it from UET VII, 126 (1-2-3-4-5-4-3-2-1). With CBS 10996, the initial triskaidecachord is made to fit within the span of the heptachord by inversion of some of its intervals. Now the original tuning method of the enneachord would not have been possible for the triskaidecachord. Therefore a new system had to be devised. It would have started with a 'b' if falling (b-e-a-d-g-c-f = b-a-g-f-e-d-c) and with a 'f' if rising (a-c-g-d-a-e-b = f-g-a-b-c-d-e). It is therefore reasonable to assume that at the time this text was written, heptatonism was the predominant, if not the only system used. However, the numbers seven, eleven, and thirteen are not regular numbers and their usage would be conflicting with the old cosmological order. I contend that this revolution was a consequence of practice: heptatonic construction is certainly far more practical for both fixed-string instruments such as the harp and the lyre but for the lute where the tuning has to be ascending, obviously.

There is, therefore, conclusive evidence that two systems, the enneatonic and the heptatonic, would have co-existed at some point during the development of theory and that this would have happened during the early first millennium BC. However, the presence of the triskaidecachord with its fourteen distinct intervals the names of which date from the Old Babylonian period since we find them in UET VII, 74, might allude to a possible precursor of heptatonism at such an early date in the development of theory. I must insist that it was a precursor - only - as we have no evidence of any heptatonic construction until the first millennium. We cannot assume that heptatonism was known before the first millennium and insistence to the contrary must be supported by conclusive evidence and not just by wishful thinking.

Fig. 14. CBS 1766, courtesy of the University Museum, Philadelphia.

conclusive evidence for the usage of heptatonism, a thousand to five hundred years before the Greeks even thought about it.

Figure 14 shows why the header of the columns resists reading at present. However, the diagram and column 2 contain the essential for our purpose.

Fig. 15. Above, CBS 1766, the heptagram.

CBS 1766

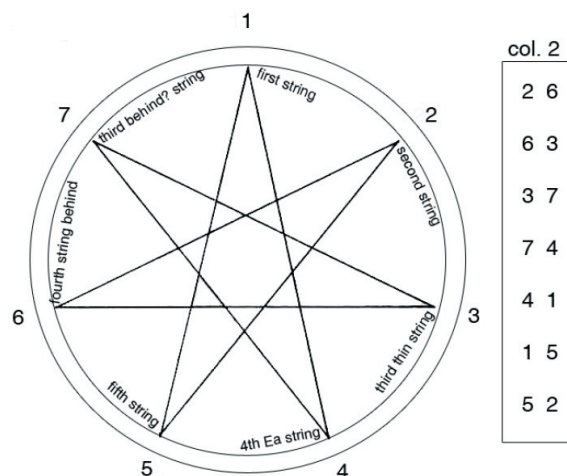This last text probably constitutes the first

Fig. 16. Right, CBS 1766, hand copy of the heptagram and of column 2.

The heptagram is conclusive evidence of heptatonism. Each of its points is labelled with the old enneatonic nomenclature but now restricted to the seven degrees of the heptachord. Also, each of its degrees is numbered in the new, first millennium heptatonic order, 1-2-3-4-5-6-7, in a manner which is in keeping with the previous text, CBS 10996. This text is distinguished from the previous one in the sense that by this time, the old triskaidecachordal interval nomenclature has been replaced by much more practical numbers. Column 2 confirms this in keeping with the first 14 lines of CBS 10996. The interval of 2-6 is no longer called *išartum*, but simply 2-6, and so it goes for all others.

The numbers in the other columns make no sense but there is no evidence that intervals others than fifths and fourths were listed.

There is however a possibility that the old string names were kept in usage to refer to the string itself and that, additionally, they had a numeric value. Thus the first string could have been tuned to pitch 1, 2, 3, 4 5, 6 or 7. This would explain the reason for the two concentric circles on the diagrams. It is possible that they represented disks which rotated one upon the other, allowing the placing of number 1 on each of the seven string names in order to generate the seven modes of heptatonism. Then the modes would have been recognised from the location of the semitone within and no longer from the tritone. It is this principle which would have been the basis for the later heptachord made up of two conjunct tetrachords, for which at present, we have no Babylonian but only Greek evidence.

Notes

1 Especially *sub* 'Mesopotamia', in *The New Grove Dictionary of Music and Musicians* 6 2001: 480-487.

2. Principally Gurney, O.R. (1973) in *Ur Excavation Texts*, Volume VII, text 126. British Museum Publication. London. see correction in *IRAQ* XLVI: 82, note 1; Kilmer, A. Draffkorn (1960) Two new Lists of Key Numbers for Mathematical Operations, *Studies in Honor of Benno Landsberger. Orientalia* 29: 273-308; Dumbrill, R.J. (2005) *The Archaeomusicology of the Ancient Near East*. Trafford: 27-36. Henceforth *AANE*. See also Duchesne-Guillemin, M. (1967) Survivance orientale dans la désignation des cordes de la lyre en Grèce, *Syria* 44: 244. More recently, Hagel, S. (2005-Mainz am Rhein) Is *nīd qabli* Dorian? Tuning and modality in Greek and Hurrian music, *Deutsches Archäologisches Institut Orient-Abteilung - Sonderdruck aus Baghdader Mitteilungen*. Band 36: 287-348.

3. Gurney, O.R. (1968) An Old Babylonian Tratise on the Tuning of the Harp, *IRAQ* XXX: 229-33; (1994) Babylonian Music Again, *IRAQ*, LVI: 101-6; Vitale, R. (1982) La musique suméro-accadienne, gamme et notation musicale, *Ugarit-Forschungen* 9: 241-265; *AANE*: 47-69.

4. Kilmer, A. Draffkorn (1960) Two new Lists of Key Numbers for Mathematical Operations, *Orientalia* 29: 273-308, and tab. LXXXIII; *AANE*: 37-45

6. Manniche, L. (1991) *Music and Musicians in Ancient Egypt*. British Museum Press: 91, 54; *AANE*: 33, pl. 4.

7. Lawergren, B. (1998) Distinction among Canaanite, Philistine, and Israelite Lyres, and their Global Lyrical Contexts, *BASOR* 309: 48, A, 11 and 12.

8. At least in a pentatonic context.

9. Dumbrill, R.J. (2008) Four Tables from Nippur. http://www.iconea.org/arane.html

10. Crickmore, L. (2008) The Tonal systems of Mesopotamia and Ancient Greece: Some Similarities and Differences. *ARANE*, http://www.iconea.org/arane.html

11. Crickmore, L. (2008) *ARANE* http://www.iconea.org/arane.html

12. West, M.L. (1992-Oxford) Ancient Greek Music: 77 *sub* enneachordon.

13.http://www.scribd.com/doc/9629654/A-History-of-Byzantine-Music-and-Hymnography

14. Herby, Archimandrite Antoine (1987-Jounieh) Petite Méthode de Musique Ecclésiastique Byzantine: 24.

15. The regular numbers from the Nippur mathematical texts are:

1	8.640.000 A-AN	25 518.000
2	6.480.000	27 480.000
3	4.320.000	30 432.000
4	3.240.000	32 405.000
5	2.592.000	36 360.000
6	2.160.000	40 324.000
8	1.620.000	45 288.000
9	1.440.000	48 270.000
10	1.296.000	50 259.000
12	1.080.000	54 240.000
15	864.000	60 216.000
16	810.000	64 202.500
18	720.000	72 180.000
20	648.000	[80 162.000]
24	540.000	[81 160.000]

TRAVELER'S TALES: OBSERVATIONS ON MUSICAL MOBILITY IN MESOPOTAMIA AND BEYOND[1]

Piotr Michalowski

Introduction

The study of music in the ancient world is an area most open to anachronistic intrusion and the interference of modernity. The practice, experience, and significance of music, before the spread of mass culture and communication, occupied very different cultural spaces than they do today, often mediating between what was narrowly local and the world at large and it is obviously difficult to establish the truly local, culturally salient elements of such practice in specific societies. Specialists who work on the subject have often been keen to reconstruct the sounds made in Near Eastern palaces, temples, and taverns millennia ago, a pursuit that may be harmless, but is, to my mind at least, nothing but folly. Even if we can reconstruct certain scales, that tells us nothing about music as such, because music is so much more than scales. To me music is organized sound that is embedded in specific social practices; we will never know the sounds and how they were structured, but we can learn something about the social realization and significance of this organized sound, and of its possible significance for the ways in which people imagined their own identities. As a small contribution to such a project, I would like to address a few issues concerning matters of local and global aspects of music in ancient Mesopotamia. Because such practices involve a constantly shifting tension between innovation and tradition, and because of space constraints, I will limit my inquiries to the earlier phases of Mesopotamian history.

In order to pursue the question of music and cultural identity, I would like to investigate, if ever so briefly, whether or not music was local or transcultural, concentrating not on scales and musical forms, but on the instruments that were used to express them. I have chosen such a roundabout manner of approaching the problem because direct evidence for artistic interchanges of the type we are interested in here are hardly ever addressed in the surviving documentation, and given the very nature of our sources, the probability that new texts will alter the situation is highly unlikely. At present, the richest information on the place of music and musicians in society comes from the epistolary mother lode from eighteenth century Mari (Ziegler 2007), but we cannot expect to recover similar material from earlier Mesopotamia because letters of this kind were not written before Old Babylonian times, and writing was not used to communicate the types of information that we would like to have on musical matters.

The mobility of musicians in the third millennium

The scant information on musical exchanges from earlier periods that we do have is brief and limited; moreover, it is not always easy to analyze. An often-cited case of musical mobility comes from the Ebla documents, which, more than thirty years after their initial discovery continue to shed light on important cultural matters, and on interconnections between different regions of the Near East in the third millennium. Although references to music and musicians are found in the Ebla texts (Tonietti 1988, 1989 and 1997), one set of personal names has garnered the attentions of those interested in such matters. As is well known, the archives contain repeated references to a group of twenty-five musicians from Mari who apparently spent some time away from home in the city to the west (Tonietti 1988: 86-89, 1989; Steinkeller 1993). This is hardly surprising, as there are good reasons to believe that Mari and Ebla were in many ways part of the same cultural complex during the third millennium. At the same time, we learn about six female musicians who came to Ebla in a caravan from Mari, but whose place of origin was the Babylonian city of Kish, and this would suggest a much broader area of musical interchange (Steinkeller 1993: 244). The matter is not as clear-cut as may seem, however. Many years ago I suggested that the Kish that is mentioned in the Ebla documents was not the northern Babylonian city, but another place that was written with the same sign but which was located in Syria (Michalowski 1985: 297-98). This issue was further taken up by Francesco Pomponio (1990), who argued in favor of the Syrian Kish, but was strongly renounced by Piotr Steinkeller (1993: 243-44). For a while I changed my mind and agreed with Piotr, but I have recently come to the conclusion that my initial hunch was correct, and that at least some of the Eblaite references to Kish refer to a place that was located somewhere on, or in proximity to the road between Mari and Ebla.[2]

These are, course, palace records, and therefore they bear testimony to elite interaction, and not to everyday contacts between societies. If the Kish in question is not the one located in Babylonia, then they only indicate that two or three cities that were culturally, perhaps even linguistically, quite similar could share musical traditions. If, on the other hand, we maintain the accepted interpretation that this refers to a city far to the south-east of Ebla, then the intermingling of musical practice and performance would indeed be more interesting, but hardly surprising, in view of iconographic evidence. It is clear that third millennium Eblaite royal self-representation strategies were in large measure borrowed, directly or indirectly, from southern Babylonia. This holds true for music as well: among the shell inlays found in the royal palace of the Syrian city there is a portrait of a musician holding a bull-headed lyre, the symbolic elite musical instrument from early Sumer.[3]

Musical terminology: some taxonomic issues

While such information is anecdotal and highly incomplete, it does provide the first clues available to us on musical crosspollination across cultures in the ancient world. One way of looking at the question is lexicographical and linguistic. This may seem to be an imperfect way in which to investigate music, but linguistic features are important because they often demonstrate cultural development when no other information is available. This seemingly commonsensical assertion becomes somewhat problematical when one steps back to examine the manner in which lexicography and semantics are treated within our discipline, and I shall return to this issue below.

The taxonomy of issues that we associate with the modern Western concept of music is difficult to trace in ancient Mesopotamian cultures. There is no word that can be glossed as 'music' in either the Sumerian or Akkadian language, and the one lexical item that comes close, nam-nar = narūtu, refers to the practical knowledge of playing, singing, and performing, and does not denote the abstract notion of 'music.' But there are indications that the semantic range of this term may have been much broader, in certain times at least. In the Ur III period, for example, the category nar, that is the lexeme that we usually translate as 'singer,' or 'musician,' also included other entertainers such as jesters and snake handlers (Gelb 1976).

The most extensive vocabulary of items that belong to this domain pertains to musical instruments, a subject that has been well covered by philologists, from Henrike Hartmann (1960) to Theo Krispijn (1990), Niek Veldhuis (1997-99), and more recently by Richard Dumbrill (2005) and Dahlia Shehata (2006), with contributions by many others. Thus we know about the textual occurrences of many instrument names, but after much labour we cannot precisely identify the items that they denote.

Indeed, after all is said and done, there is only one such label that can be associated with a specific instrument: we know from an illustrated ritual tablet from the late first millennium that the lilis = lilissu designated a large kettle-drum (Thureau-Dangin 1921 no. 47);[4] no other well founded identification has been made since then, although there have been many suggestions that have become philological facts by means of constant repetition, even though many of them are clearly wrong, such as the identification of the zami with the bull-headed lyre (Michalowski 2009).

The reasons for this state of affairs are fairly obvious to all: the two main culprits are the ancients who refrained from providing us with any useful descriptions of musical instruments, and the limitations of traditional lexicography that is the basis for much assyriological work. Briefly stated, our lexicography is concerned with the glossing of terms in one language with terms from another one, be it German, English, French, or Italian. As important as such dictionary work is, although it was famously much maligned by Samuel Johnson, it sometimes misses the fact that the semantic domains of words in different cultures do not always correlate in a precise manner. Already Ferdinand de Saussure (1916), at the beginning of the last century, used the example of French mouton and English sheep, mutton, etc., to being attention to this problem, and in the fifties, sixties and seventies of that very century, the ethnoscience movement among anthropologists and linguists focused on the way in which language labels the world, not in discrete words, but in lexical sets that provide insight into cultural categorization. One such debate, which is of importance for our subject, shed light on the matter of covert categories and unique beginners in taxonomic systems. This discussion arose from observations that many elaborated folk classification systems appear to lack a general overall label, such as 'plants,' or 'animals,' and yet exhibit complex semantic sets that suggest the covert notion of a set, even if it lacks a label in the language—thus one can have a semantic set of music, or musical instrument, even if the general label is not lexically explicit. In recent years scholars who work on ancient music have adopted certain unmellifluous terms such as chordophone or membranophone from the rather dull field of organology, but have ignored more informative studies of folk classification. To illustrate the classificatory possibilities, I will provide two radically different examples of the way in which cultures can categorize instruments. The first comes from the Solomon Islands in the Pacific (Zemp 1978: 37):

Among the 'Are'are are people the lexeme 'au signifies "bamboo" at the most general level and contrasts with other categories of plants, such as 'ai, "tree." At the level of the utilization of the plant material by man, 'au means "musical instrument(s) [of bamboo]' and contrasts with nahe, "bam-boo used in cooking," for example. All musical instruments

which can produce a melody are made of bamboo, and it is with the term 'au that the 'Are'are people designate European musical instruments and the objects which transmit western music, such as radio, record player and tape recorder.'

My second example is a bit closer to home, from the sixth/seventh century C.E. polymath Isidore of Seville, whose Twenty Books of Etymologies or Origins included a discussion of music in Book Three (Ceulemans 2002: 9-10):

'Isidore classifies instruments according to the "nature of their sound", which may take three "forms." The first is harmonic and is represented by vocal music; the second is organic and is generated by breath; the third is rhythmic and is produced by striking the fingers. Isidore thus distinguishes between two categories of instruments: wind and percussion. To this latter category string instruments belong as well as what we should now call percussion instruments in the strict sense.'

On the surface, these two examples - and one could cite many more - bring to mind the notorious Chinese encyclopedia imagined by Jorge Louis Borges (1993:103), in which animals were categorized as belonging to the emperor, embalmed animals, those that are trained, suckling pigs, mermaids, fabulous, ones, stray dogs, included in this classification, etc.[5] Borges' playful comment, that 'obviously, there is no classification of the universe that is not arbitrary and conjectural' can lead to despair or to much cultural understanding, but, as cognitive athropology showed us decades ago, there is much to be learned from the structure and logic of native classification. The 'Are'are use of the word that we gloss as 'bamboo' on more than one taxonomic level is instructive: Sumerian labels such as balaǧ or tigi may also work in similar ways.

Of course, we have no comparable descriptions from the ancient Near East, but the examples cited above should provide a warning: we should not always try to relate single Mesopotamian lexical items to ancient pictorial representations or models, nor with modern instrument exemplars, because we simply do not understand the logic of the native taxonomies. This is an issue that is not limited to musical instruments, but embraces, as is well known, many other lexical sets. Consider, for example, matters connected with botanical taxonomy, more precisely the contested problem of the definition of the Sumerian tree name eren, whose wood and resin was imported or plundered from both Iran and the Lebanon. Until recently, the standard translation of this eren has been 'cedar,' although a number of us have questioned this definition.[6] It is fairly certain that the term encompassed a broader range of resinous tree taxa that we would identify as

'juniper,' 'cedar,' and even possibly also as 'pine.' Therefore, the label operated on various levels of the taxonomic hierarchy, sometimes used for specific labels such as 'juniper' or 'cedar,' which are often confused or blended in folk classifications, and in other contexts bearing a broader semantic load, referring to aromatic resinous woods with certain characteristics.

Some Mesopotamian instrument names

The history of early Mesopotamian instrument names is difficult to recover from the limited information available at present and the comments that follow are not intended by any means to be complete. The earliest cuneiform texts, the fourth millennium tablets from Uruk, seem to include only one sign that designates a musical instrument, a pictograph of a string instrument that is apparently the antecedent of the later balaǧ sign.[7] For the moment I will set aside the contested interpretive issues associated with this identification, and move on to the middle of the third millennium, when the evidence becomes a bit clearer. In the chart below, the left hand column contains the listing of musical instruments from an Early Dynastic thematic lexical text; the right column includes possible later equivalents or similar names.

Early Dynastic (EDPV-A)[8]   Old Babylonian and Later

(c. 2700)	(1900-)
balaǧ	balaǧ
balaǧ dilmun	*telmunnum*
balaǧ ma-ri$_2$^{ki}	*ma/irītum*$^?$
bur$_2$-balaǧ	
li-li	li-li-is$_3$, Akk. *lilissu*
gi-di	gi-di
gi-tag/GI×TAK$_4$	
GIŠ×TAK$_4$	
TAK$_4$.AB$_2$.TAK$_4$	ub$_5$, Akk. *uppu*
RU.RU^{uruda}	
si am-si	

The interpretation of such texts is, as we all know, hardly a simple matter. Is the word balaǧ, which opens the section, a general term or does it refer to a specific instrument, and if it is a higher taxonomic label, does it refer to percussion or strings, or even to the general concept 'musical instrument' itself (Civil 2008: 99). In another contemporary lexical list from Ebla, the word/sign balaǧ is explained as *gi-na-ru$_{12}$/rum$_2$/lum* (Civil 2008: 99). The writing *gi-na-ru$_{12}$* also occurs by itself in a list of instrument names in an unpublished lexical text of unknown provenance, possibly from Umma (Civil 2008: 99). These are the earliest attested example of a word that is found in many languages of the Near East and the Mediterranean,

but is otherwise unattested in the Mesopotamian world, reappearing a millennium later in the Mari texts, and will be discussed more fully below. Whatever its origins, I would be reluctant to attempt any identification in this period, or at Mari, I would add, as terms of this type often change reference. Note that in ancient Greece the related word kithara designated a lyre, while in Modern Greek it is used for the guitar. The Hebrew *kinnor* has attracted much discussion, and the identification with a harp is somewhat dubious, if widely accepted. I would reacall, in this context, the famous example of Greek *pectis*, which originally designated a type of harp, then a lute, but ended up as a word designating the panpipe (West 1997). It is possible that at Ebla *kinnārum* was a general classificatory term, much like Mesopotamian balaĝ.

One other instrument name may be implied in an early representation, in what is arguably the first pun in recorded history. The front inlay of the famous great lyre from the Royal Tombs of Ur includes a representation of a gazelle bringing beer in a cup (Aruz and Wallenfels 2003: 106). The symbolic value of the whole scene may be beyond our understanding, but one can suggest that at some level, at least, it involved a set of puns in a Semitic language; in later Akkadian the word for gazelle is *ṣabītum*, playing on *sabītum*, 'alewife, innkeeper, beer merchant,' and even, more remotely on the instrument name *sabītum*, 'of the Sabum type.' The latter, first attested in Ur III times, is presumably associated with the Iranian town of Sabum (Krispijn 1990: 10).

There is very little philological information on our topic for the next few hundred years, but more information on the subject surfaces towards the end of the third millennium. Here is a summary of the main instrument names as attested in the writings from the time of Gudea of Lagash, the Ur III periods, as well as from Old Babylonian literary texts:

INSTRUMENTS ATTESTED IN Ur III & O.B. TEXTS (c. 2200-1750)

The chart is self-explanatory, but what is remarkable is the definite continuity of musical instrument labels in Sumerian language texts over a period of almost half a millennium. Also important is the fact that the terms are different from what came before, as almost half of the items listed in the Early Dynastic lexical list discussed earlier have no later equivalents. One must therefore ask if the disparity is due to changes in musical practice, in divergence inherent in various social and organizational environments, or whether it is a reflection of changes in writing conventions. It must be kept in mind that the Sumerian literary language that we are investigating here was an artificial construct that was unrelated to the vernacular of the time for most, if not the entire time span under

GUDEA	Ur III & EOB	OB LIT
balaĝ	balaĝ	balaĝ
	mārītum	*mārītum*
	sābītum	*sābītum*
	zag-mi$_2$	zag-mi$_2$
	tigidlu	tigidlu
	sa-eš	sa-eš
	li-li-is	li-li-is$_3$
a$_2$-la$_2$	a$_2$-la$_2$	a$_2$-la$_2$
si-im	šem$_3$	šem$_3$
a-dab$_6$		a-da-ab
ti-gi$_4$		tigi
		har-har
		za-am-za-am-ma
		me-ze$_2$
		za-na-ru
		gi-di
		etc.

discussion, although this is a matter of some controversy. Therefore, many elements of this set could be traditional, and might not accurately reflect contemporary use. The pictorial record is much less diachronically consistent: for example, the lute appears for the first time during the Old Akkadian period (Collon 1980-83), but is mainly found on Old Babylonian representations, the small vertical harp seems to disappear after Early Dynastic times, and the bull-headed lyre is never gone forever after the Ur III period. Similarly, economic documents paint a very different picture of instrument use in the early second millennium, and most often mention instruments such as the tigidlu and *sābītum* that are less common in poetry, although the big drum ala seems to persist in the temples of the land.

Seal designs and other representations suggest that prototypically, secular gatherings were conducted to the sound of string instruments, while percussion dominated the cult. Many Early Dynastic scenes include just one instrument, usually the bull-headed lyre, but that should not be taken as a realistic representation, but only as a symbolic type-scene, where the lyre represents music in general, although emblematic of formal elite interaction (Michalowski 2010). Less official functions, and the lower ranks of society were marked by the use of a different instrument in Early Dynastic times, namely the hand held harp, seen here in a selection of seal designs from the Royal Cemetery of Ur. Just to complicate matters, the harp can also be used in elite environments, but the lyre is never found in any other context.

The lyre seems to be a characteristic southern Mesopotamian instrument, but there is some evidence of its presence elsewhere during this time. There is one

clear representation of a bull-headed instrument on at least two seals from the island of Falaika in the Persian Gulf, and Asko Parpola (1996; also Flora 1998: 133) want us to believe that it is also depicted on one or more similar objects excavated at Chanhujo-daro in the Indus Valley. Another string instrument that may have international connections is a harp that is represented on a fragment of a third millennium stone bowl that was excavated at Adab, in the heart of Sumer. The harp is somewhat different from those normally found in Mesopotamia, and it has been suggested by a number of scholars that it is an Iranian or even Indian instrument (Steinkeller 2006: 7-10). The Adab bowl was manufactured in Iran, usually with Mesopotamian artistic motifs for local consumption, but may simply reflect Iranian rather than Mesopotamian practice; indeed, a few depictions of similar harps are found on seal engravings from Iran. This kind of harp has a long history; as Judith Becker (1967) has demonstrated, it became domesticated in India, from where it traveled east to Burma in the fifth century of the Common Era. Steinkeller cautiously identifies this harp with the instrument name *paraḫšitum*, commonly used in the Mari texts, but this is only a conjecture. Whatever it may have looked like, it certainly was considered to be of Iranian origin, linked at some point in time with the far-off land of M/Barḫaši.

Ancient string instruments had limited sound projection capacity and were generally used indoors. For outdoor ceremonies, with bigger audiences, drums were simply a necessity, although large string orchestras could possibly have been used as well, but currently we have little evidence for the use of multiple human players in public before the second millennium, and the animal scenes, which of course show a variety of strings, woodwinds, and percussion, are a different matter altogether. Public ceremonies, especially those of mourning, involved the drum.

There is no native explanation of this apparent dichotomy in any literary composition, but such a classificatory distinction is perhaps to be found in certain administrative documents. In Ur III texts from Drehem, Umma, Ur, and Girsu there is a distinction between two general types of entertainers or musicians, nar sa and nar balaĝ, 'players of strings,' and 'players of balaĝs,' as evidenced in one text (RTC 399 iii 24, 31, IS3) which lists people belonging to these two categories.

The use of the word balaĝ to designate a whole class of instrumental practice, possibly what we would describe as percussion, raises once again the issue of higher taxonomic labeling. Recall that the balaĝ sign, a pictograph of a lyre, is the only identifiable sign for an instrument in the Uruk texts, but in the Early Dynastic lexical list it was used either for a class of instruments or for all of them, heading the section. Keeping in mind the changes documented in other cultures, as well as the different usage

of strings and percussion in early Mesopotamian society, it is not difficult to imagine that the denotation of the word balaĝ may have undergone many changes in the course of a millennium or more, from a lyre to a class of instruments, to percussion, and even a general term encompassing all of them.

Instruments from foreign lands

I would like to step back and to take another look at the lists we were looking at earlier. A glance at the instrument names attested in third millennium texts reveals a fascinating pattern: many of the Mesopotamian words that designate musical instruments are either associated with foreign lands (Mari, Dilmun, Sabum, Marḫaši) or are not etymologically Sumerian, indeed the syllabic spellings of most of them strongly suggest that they are loans.[9] The same holds true for those that are normally written with logograms, such as tigidla, which is certainly a borrowing from another language. I would even think that the same must be said of our notorious balaĝ; indeed Miguel Civil (2007: 18) lists it among the words he suspects must be Afroasiatic in origin, although he also remarks that it is probably onomatopoetic. Admittedly, some instruments may be onomatopoetic in origin, while a few, including urzababa, are indeed Sumerian.[10] All of this tenuous evidence for musical interchange over long distances brings us back to something that we mentioned in passing above. This suggests that some time before 2700 B.C.E. or so there was enough strong cultural contact with other peoples to create a strong musical imprint on Mesopotamian musical practice. This is hardly surprising, and it has fascinating analogies elsewhere, most notably in neighboring civilizations. To the east, I will only mention one: the Old South Indian vīṇā instrument name, which has no known Sanskrit etymology, leading one authority on the subject to write (Wrazen 1986: 36, see also Coomaraswamy 1931: 49):

'there is little agreement concerning the word's origin beyond the general admission that it is of foreign origin… Otherwise, its ancestry has been attributed variously to Persian, Iranian, Armenian, Mesopotamian, or Egyptian sources, depending on the author.'

If we look towards the west, we find an even more dramatic situation. To cite Colin Renfrew (1998: 247) on the subject:

'It seems a remarkable circumstance that most of the terminology for musical instruments in Classical Greek is recognizably non-Greek linguistically, and in some cases non-Indo-European.' This includes such basic items as *kithara, syrinx, phorminx, and lyra.*'

W. W. Ivanov (1999) has developed this even further, providing additional etymologies and word histories.

It therefore seems that from Greece to Mesopotamia, and even through to India, music and musical instruments traveled and left various imprints on language and culture, and that this procedure can be traced back to before the use of writing in these areas.

Many of the early Sumerian instrument names may be of foreign origin, but they were nativized, and some of them were eventually borrowed into Akkadian. But once one moves into other realms of musical terminology, such as words for ensembles and for string names, it is all Semitic. The Old Babylonian music texts are redacted in that language, and not in Sumerian. The Sumerian versions of the string names appear for the first time in the middle of the second millennium, in a lexical text, and are never attested in any other context; indeed it is most probable that they were a scholastic invention, created for the purposes of the bilingual lexicographical context (Michalowski 2009).

The Mari situation is instructive: most of the terms, some of which are not attested in Babylonia, are apparently Akkadian, including loans from Sumerian such as *urz-ababittum* or *tigetum*, including ones refer to their foreign origin, such as *paraḫšitum* and *telmunum*. But the written language of Mari at this was a form of Akkadian that had only recently been imported for local used from Ešnunna to the east, and is different from the Semitic language used earlier, during the so-called *šakkanakum* period (Durand 1985: 160-172). At present I do not know of any musical terms in the texts from the earlier periods from the city, many of which remain unpublished.

It is therefore possible that much of the Akkadian musical terminology, including *šitrum, mummum, tegetum*, etc., was part of this later intrusive official language, and may not have been in use at Mari before 1800 B.C.E.

The case of *kinnāru* is instructive and requires a bit more detailed discussion, even if this is not the place for a complex philological and linguistic argument. The root *knr*, designating a musical instrument, occurs in a number of West Semitic languages, including Ugaritic and Hebrew, but is noticeably absent from Akkadian, except in texts from Old Babylonian Mari and then as a West Semitic loan in mid-second millennium texts from Alalakh and Emar.[11] Unlike many who have considered this as a native Semitic word, W. W. Ivanov, in a number of studies, culminating his 1999 essay on the lyre, has proposed that it is an ancient culture word that is also reflected in the well-known Hattic instrument name zinar (de Martino 1987). The argument is a complicated one, and the details are of little relevance here, except to say that this ancient word was loaned into various ancient Near Eastern languages in two different forms, which can be normalized, if only for practical purposes, as *kinnāru* and *zannāru*, with the initial /z/ representing a palatalized /k/ before a front vowel.

It is interesting to observe how these loans play out in Sumerian, Eblaite, and Akkadian. As already noted

above, the form with initial /k/ is attested in Eblaite, and is also used, as a loan in two Early Dynastic lexical texts. One of them may be from Umma, but other than this the word never gained any traction in Mesopotamia, at least not in that form, but was borrowed somewhat later, it would seem, in the form with initial /z/, as evidenced in the Old Akkadian writings (Steinkeller 1993b:144). In somewhat later Old Babylonian poems it is found loaned into Sumerian as (gis)za-na-ru (Krispijn).[12] The form *kinnārum* does resurface in the Akkadian used at Mari but its origin at this moment is unknown. It could have been borrowed from Amorite, but more probably it was a holdover from the earlier 'šakkannakum period' language, which derived from a Semitic dialect continuum that earlier included Eblaite.

Conclusions

This is an admittedly brief and somewhat hasty look at some of the issues surrounding Mesopotamian musical terminology. I would now like to use this information to return to some of the broader cultural issues that sparked my initial discussion and briefly summarize some conclusions. If I am right, very little of Mesopotamian musical terminology is Sumerian in origin. Like many languages, Sumerian lacks a word that would correspond to what we in the modern West mean by music, as nam-nar seems to refer to a broader range of entertainment activities. The music instrument names are borrowed from other sources, and much of the other parts of the musical lexicon are Akkadian. This procedure of lexical and musical crosspollination did not end early on, but was an ongoing, dynamic procedure. Moreover, already in the third or early second millennium certain words announce the foreign, or putatively foreign origin of instruments, from Sabum and Marhashi in Iran, Dilmun in the Persian Gulf, and Mari in Syria on the Euphrates. We have seen the movement of instruments from Mesopotamia to Ebla in the west, and possibly even to India in the east. The relatively homogeneous picture of instrument names in second millennium poetry contrasts with evidence of more heterogeneous musical practice as documented in other types of evidence. In view of all of this it is difficult, given the kind of information that we have, to speak of a uniform category of Sumerian music at all. Much of what is portrayed as Sumerian musical culture is imprinted with influence from far and wide; indeed, as is probably the case with so much of southern Mesopotamian traditions, it is eclectic, ever changing, and open to influence from others. Even so, it is difficult to imagine how much of actual musical practice, social as well as musicological, traveled to and from Mesopotamia in association with words and physical implements. All of this only confirms what some of us have been asserting for some time, namely that the notion of a Sumerian culture is a chimera and that the

adjective should be reserved solely for the earliest attested language of southern Babylonia, derived from the Semitic geographical term Šumer. To those who still pine after a reconstruction of Early Mesopotamian music I can only say that not only was it eclectic and constantly shifting under various influences, internal and external. It was also highly differentiated, and there is little reason to think that the traditional intoning in the temples was similar to the formal, as well as informal status-affirming entertainment of the palaces, the fun of the streets, or the happy frolic of the tavern.

Notes

1 This paper is a lightly edited version of the one presented at the conference and is not intended as a full exposition of the topics it addresses.

2 In texts that purportedly describe the movements of troops from Ebla against Mari, people from Kish delivered meat along the way (Archi and Biga, 2003). It seems completely improbable to me that armies moving in Syria would have required deliveries of meat from Kish in Babylonia.

3 Illustrated in Aruz and Wallenfels (2003): 160.

4 On the *lilissu* in late Babylonian times, see Linssen (2004): 92. This instrument name, as well as balaĝ, has the longest attested history of any such term, from Early Dynastic to Hellenistic times.

5 This famous passage comes from 'The Analytical Language of John Wilkins,' first published in 1942.

6 The translation "cedar" of Sumerian eren has been problematical for some time, as there is no evidence for cedars growing in Iran; see already Michalowski (1978: 118). Leonid Kogan presented a detailed discussion of the problem, with the proposal that it refers to a type of juniper, in a series of lectures at the College de France (2007). He is preparing a published version of his analysis.

7 Some have questioned the connection between the archaic sign ZATU 47 and later BALAĜ, but the matter seems to have been laid to rest by Jerrold Cooper (2006: 41 n. 6).

8 This is the Early Dynastic Practical Vocabulary A: 205-215, known from Ebla and Abu Salabikh sources, edited with commentary in Civil 2008: 39-40; 99-102. For a comparison of this passage with two other Early Dynastic lexical lists of musical terms, see Civil (1987: 137).

9 Note that instruments of the Mari and Dilmun type are already among the first items listed in the Early Dynastic lexical text cited above. The entry li-li, for later li-li-iz$_3$ is also a loan, as evidenced by the syllabic writing.

10 This instrument name is usually associated with King Ur-Zababa of Kish, (Krispijn 1990: 11), but it is more probable that it is to be connected with the town Ur-Zababa (for Ur III attestations and location see now Steinkeller 2010). Note, however, that this place is already attested in a third millennium lexical text, the *ED Names and professions List* 91 (*OIP* 99 61 obv. iv 6' and dupl.).

11 Many have discussed the word; for broad summaries see Grelot, (1978), Lowengren (1998), and Ivanov (1999).

12 In later Akkadian lexical texts it appears as *zannāru*; this is clearly a learned loan from the Sumerian.

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MUSICAL ENSEMBLES IN ANCIENT MESOPOTAMIA

Theo Krispijn*

1. Introduction

In Mesopotamian literature, especially in the context of religious festivals, ensembles of musical instruments are regularly mentioned. Furthermore, the playing of official as well as popular music is depicted fairly often in Mesopotamian visual art. It therefore seems plausible to compare the groups of names recorded in texts with the groups of instruments represented iconographically from similar periods. Archaeological excavations have found actual instruments, sometimes in groups, and these will also be taken into consideration. Not surprisingly there has been much learned discussion about the correct translation of Sumerian and Akkadian words for musical instruments and how best to relate them to the instruments depicted or excavated. In this paper I hope to contribute to the discussion by identifying names that are grouped together with some particular depictions of instruments in ensembles.

One textual source to be used will be passages from literary texts concerning festivals and other events where music was played. Another will be the lists on which the names of musical instruments are systematically ordered. These lexical lists comprised selections of Sumerian words from a given semantic field, sometimes translated into another language, and were used in the process of educating the Mesopotamian scribe. Since we have reason to suppose that there was an amount of speculation in these lists and that the scribes could also use theoretical names in their urge to omit nothing they need to be treated with some caution.[1] The administrative texts from the Ur III period (± 2000 B.C.), especially those from the Ur and Umma workshops where musical instruments were produced, is an additional source. The texts are interesting but deserve a separate study so they will be referred to only as the occasion arises.

The Royal Tombs of Ur (± 2650 B.C.), excavated by Sir Leonard Woolley, with their beautifully decorated instruments which were accurately reconstructed using the team's advanced techniques, are a rich source for archaeological material. Those instruments that were found together can be considered as a musical ensemble. Iconographical sources are also rich, with cultic scenes featuring the playing of instruments found on stelae, statues, bas-reliefs, cylinder seals and vases.

The various sources, lexical, literary, iconographic and archaeological, will be dealt with in a chronological order. But separating by millennia is a somewhat artificial scheme which will have to be later refined.

2. General classification

Before examining the textual and pictorial material to be compared, a general classification of the terms used for musical instruments in Sumerian and Akkadian order is required.[2] The instruments themselves are generally classified as chordophones, aerophones or percussion instruments, including the membranophones and idiophones.[3]

The pictographic signs used for the names of the instruments provide clues to identifying them in the texts. These clues can be refined by descriptions in later lexical and literary texts, where specific materials used in their construction are mentioned by means of determinatives: ĝiš 'wood', gi 'reed', kuš 'skin, leather', uruda 'copper, metal', and zabar 'bronze'. This evidence is correlated in the Glossary.

2.1 Chordophones:

According to its pictogram the balaĝ was a chordophone, a harp,[4] and so it is probable that the associated composite terms, BALAĜ.NAR (= tigi) and BALAĜ.DI (= dubdu), are also chordophones. As a determinative sign some chordophones have not only 'wood' but also 'hide', since some wooden parts are covered with hide. I have earlier identified the alĝar and the alĝarsur, which occur in later texts directly after ala, as horizontal harps played with or without plectrum (Krispijn, 'Beiträge': 9-10), but this is now disputed by Veldhuis and Shehata (see Glossary). Although there is still no general accepted identification for the zamin, most scholars now tend to translate it as 'lyre'. Zannaru, a type of lyre, is a loanword from Hattic zinar. Presumably miritum 'instrument of Mari', sabitum 'instrument of Sabûm' and *parahšitum* 'instrument of Far(a)hšum/Fars' are regional types of chordophone. urza(ba)bitum is a chordophone named after someone called Urzababa, possibly the king of Kiš mentioned in the Sumerian Sargon Legend.[5] Urgula 'lion' is always mentioned among other chordophones but identifying it is unclear. Gusala 'neck to which strings are attached' and siezen 'fret' or 'tuning peg' are probably terms for the lute or for parts of the lute.

Aerophones:

Gisug, gitag and gidid are all composite terms written with the sign gi 'reed'. These are the aerophones

probably to be identified with the flute or oboe. There is some confusion in later texts between gigid and gisug (see Glossary). The adara 'ibex horn' and siamsi 'elephant tusk' comprise the horns.

Percussion:

Nele Ziegler has recently proved that the ala is a big drum (see Glossary). It is written with the determinatives for wood, hide or metal (copper). In later texts šim/ub drums have the determinative for hide as well as their normal determinatives for wood and bronze. Since adab and zamzam have the determinative for metal (copper) in late texts they can be regarded as percussion instruments.[6]

Singers:

In the early lexical lists there are several terms for singers. From the Uruk period onward the general term nar 'singer, musician' is found. gala 'lamentation singer' occurs only in inscriptions from the late Presargonic period (± 2400 B.C.). Other terms are šud 'singer of prayers' and šir 'singer of songs, composer'.

3. Musical instruments from the 3rd millennium B.C.

3.1 Musical instruments in the lexical lists of the 3rd millennium B.C. (tab. 1.1)

In the early lexical lists most chordophones (including the players and the songs they accompany) are denoted by the sign balaĝ 'harp' or componds with balaĝ. The lexical series E.D. Lu A of the Uruk IVa period (± 3200 B.C.)[7] already includes gal balaĝ '(leading) harp player'[8], and later lexical lists (Fara period ± 2600 B.C.) have balaĝdi 'singer of harp songs', balaĝ dilmun 'Dilmun harp', balaĝ mari 'harp/instrument of Mari', burbalaĝ '(player of a) special type of harp', and tigi (= NAR+BALAĜ literally 'harp of the singer'). The only other chordophone which could be included in the early lexical lists was gal.zà '(leading) lyre player' or 'singer of songs of praise' (?) (E.D. Lu A 108). zà follows gal šùd '(leading) prayer singer' and therefore could possibly be an abbreviation of zà.mí (zamin) 'lyre'. An objection against this suggestion is that zamin does not occur among musical instruments anywhere else in later lexical lists or literary texts of the 3rd millennium. It is only a word, written zà.me, meaning 'to be praised' or 'song of praise'; *cf.,* zà.me = *wādium* 'someone who praises' (VE 1181). However, the etymology of zamin 'wide side' suggests an object like a musical instrument.

Three types of aerophone occur in the lists as composites with 'reed', gidid, gisug and gitag, flutes and oboes, and one as a composite with si 'horn', siamsi 'tusk of the elephant'.

Several percussion instruments are listed: ala 'big

drum' ĝištag 'wooden drum', ruru 'curved clapping sticks', šim/ub 'drum' and zam(zam) a drum or idiophone. The main pictogram for drums is AB$_2$xZAG that later becomes AB$_2$xTAK$_4$. According to its pictogram it was a slightly diabolo-shaped drum (fig. 2).

3.2 Musical ensembles in the literary texts of the 3rd millennium B.C. (tab. 1.2).

The only musical instruments in the literary texts of the Presargonic period, tigi and balaĝdilmun (chordophones), occur singly.

From the Gudea period (± 2100 B.C.) onward ensembles are mentioned.

Three sorts are found in the Gudea inscriptions:
 • Chordophones and percussion: 5, 7.
 • Only chordophones: 6.
 • Only percussion: 4.

The chordophones that are mentioned are alĝar, balaĝ, miritum and tigi, and the percussion instruments are adab, ala, šim/ub.

In Gudea Cylinder A VI-VII (3) the precious balaĝ, which is brought into the temple as a votive gift, is called ĝišgudid 'loud-sounding wood'. ĝišgudid is an epithet of different instruments. To identify ĝišgudid as a lute as early as the Gudea Period is improbable, because lute-like instruments do not figure in official ritual.

3.3 Survey of musical ensembles (instruments) excavated or occurring in 3rd millennium iconography. (tab. 1.3.1-2).

The following combinations occur:
 • Chordophones (big lyre; vertical harp) and percussion (big drum, sistrum; clapping sticks): 3, 9, 11, 13, 14.
 • Chordophones (vertical harp; big lyre; small lyre A-B) and singer(s) (and people clapping): 4, 5, 6, 7, 8, 15, 16, 21.
 • Chordophones (vertical harp), percussion (big drum; clapping sticks) and singer(s) (and people clapping): 1, 12, 19.
 • Chordophones (horizontal harp; aerophones (ram's horn), percussion (small drum) and singer(s): 2.
 • Percussion (big drum; small drum) and people clapping: 20.

From table 1.3.1 it is clear that the vertical harp is more popular in the first half of the 3rd millennium and the big lyre in the second half, although the latter occurs as early as 2800 B.C. (3). The earliest evidence of the horizontal harp (2) is an imported piece found in Adab. Its style suggests an import from Iran and so it remains an isolated case in this early period. Only after 2000 B.C. do horizontal harps really from Mesopotamia occur in iconography (R 61, 71-75). Two types of small lyres occur: type A (5, 6, 16) and type B (15). Type A is a lyre comparable with the big lyre but on a smaller scale.

Type B rather resembles later Syrian lyres. The first lutes appear as a solo instrument (17, 18) in iconography during the Sargonic period.

The figures on votive plaques and cylinder seals who hold their arms crossed, separating them from the chest, I have interpreted as singers. Such a figure in this pose is seen on 'The standard of Ur' (6) in the upper register at the right. His hairstyle resembles the statue of the singer-harp player Urnanše from Mari (Z: 33). The iconography of singers will be discussed further elsewhere.

3.4 Identifications.

Comparing textual with pictorial evidence for ensembles conveys the following impressions:

• The chordophones depicted in combination with percussion instruments dating from the first half of the 3ʳᵈ millennium could be the balaĝ and the tigi. Since the pictogram for balaĝ is a harp, the harp in the images is most likely to be a balaĝ. But it is also possible that in the course of the 3ʳᵈ millennium balaĝ develops into general word for a musical instrument, for it is often the first entry for musical instruments in the lexical lists. tigi is a word found in the earliest literary texts and is apparently the word for the big lyre which features in 3ʳᵈ millennium iconography.

• In the ensembles of the Gudea period the chordophones include the alĝar 'horizontal harp' as well as the balaĝ 'harp' and the tigi 'big lyre'. A likely word for the small Mesopotamian lyre (type A) is zamin. The miritum, also mentioned as an ensemble instrument could be the small Syrian lyre (small lyre type B), depicted in (Table) 1.3.2 15.

• The percussion instruments adab, ala and šim/ub could be identified with clapping-sticks, big drum and small drum.

4. Musical instruments from the 2ⁿᵈ millennium B.C.

4.1 Musical instruments in the lexical lists of the 2ⁿᵈ millennium B.C. (tab. 2.1)

In the O.B. (Old-Babylonian henceforth) lexical lists the section of chordophones is considerably expanded. The O.B. Hh I begins with balaĝ, its derivations and parts. From the 3ʳᵈ millennium lexical material balaĝ, balaĝdi, as well as miritum (earlier balaĝ mari), tigi and zamin return. New instruments in the lexical lists include alĝar, alĝarsur, dua, ĝišgudid, harhar, niĝharmušen, sabitum, šukara, tigidla, urgula, and urzababa. Ĝišgudid is originally an epithet for several instruments, but from the O.B. onward it often functions as a term for lute and is listed among terms for lutes (tigidla, dua, šukara). Alĝar and alĝarsur are 'horizontal harps' (see Glossary). As well as the miritum, the sabitum 'instrument from Sabûm' is another imported instrument. In Šulgi B 164 and other texts sabitum is attached to alĝar,

indicating that the sabitum is a type of horizontal harp. Sabûm is a region in north-western Iran from which the earliest examples of horizontal harps (tab. 1.3.1 2) are imported, so it is almost certainly another type of horizontal harp. urzababa, urgula, harhar and niĝharmušen could be types of lyres. Types of lutes (tigidla, dua, šukara) occur now for the first time in the lists.

The aerophones gidid and gisug were mentioned in the earlier lists, but adara 'horn of the ibex' is new. The percussion instruments found again are ala 'big drum', šim/ub 'small drum' and zamzam, a percussion instrument, but, meze 'sistrum' or 'rattle', papa 'pair of clapping sticks' (?), and lilis 'timpanum' are new. adab, originally a percussion instrument, perhaps 'clapping-sticks', is now used exclusively to indicate a type of song. Perhaps malgatum '... from *Malgium*', a type of song, was also originally an instrument but this is uncertain.[9]

4.2 Musical ensembles in the literary texts of the 2ⁿᵈ millennium B.C. (tab. 2.2.1-3).

The ensembles of the 2ⁿᵈ millennium literary texts when compared with those of the late 3ʳᵈ millennium display a greater variety of instruments:

• Chordophones and percussion instruments: 2B, 3A, 4, 5A, 5B, 6A, 6B, 7, 9, 11, 14, 15A, 15B, 17, 18, 19A-B-C.
• Chordophones, aerophones and percussion instruments: 2A, 12, 13, 21.
• Only chordophones: 5C, 22 (tigi 100x).
• Only percussion: 1, 3B, 8, 10, 20, 23.

The chordophones mentioned in the literary texts are horizontal harps: alĝar, alĝarsur, sabitum; vertical harps: balaĝ, balaĝdi, ĝišgudid (?); the big lyre: tigi; small lyres: zamin, miritu. si'ezen is attested as a device on the lute, a 'fret' or 'tuning-peg'. When it is mentioned in the dispute 'Winter and Summer' (14) together with well-known instruments of official ensembles, it is not a lute but a harp. From the aerophones adara and gisug occur and the percussion instruments ala, gurtur, lilis, meze, papa, šim/ub, šim(da), zamzam. Adab is exclusively used as a term for a type of song in this period (4, 16, 17, 19A-B, 21), as in the lexical lists. Relatively often the combination tigi, ala and šim is found, which was apparently a standard ensemble for the cult (5B, 6A, 6B (+other instruments), 7, 9, 11, 14, 15A (B), 18.

Passages in hymns dedicated to king Šulgi (especially Hymn B) pay broad attention to his musical abilities.[10] Individual musical instruments are listed in a way that is reminiscent of lexical lists. Such passages, accumulating the names of all the instruments and how they were played, occupy an intermediate position between lexical lists and literary texts. It also explains why instruments occurring only in Šulgi hymns B and C are found in the lexical lists but not in other literary texts:

• lyres: urzababitum (lyre ? lex. – lit.), zannaru (lit.)

• lutes: dim (lit.), šukara (lex. – lit.), urgula (lex. – lit.), zannaru, found for the first time in the literary texts, is a loanword from Hattic *zinar* and so must be the 'Anatolian lyre'.

4.3 Musical ensembles occurring in 2nd millennium iconography (tab. 3.3).

Almost all depictions of ensembles from the O.B. period belong to the realm of folk music. That makes them less suitable for comparison with the ensembles in literary texts, since almost always only official music is described in them. On terracotta plaques of the O.B. period several instruments are depicted individually: vertical and horizontal harps (type A and B), big lyre, ram's horn and flute (tab. 3.3 0).

The following combinations occur:
• Chordophones (lute; small lyre), and percussion (small drum): 4, 5.
• Chordophones (horizontal harp, lute) and singer(s): 1, 3
• Chordophones (small lyre + lute): 6
• Percussion (big drum, clapping sticks): 2.

Folk music scenes show combinations of two instruments, a small lyre or lute with a small hand drum (4, 5). The Middle Babylonian, M.B., henceforth, example 6, where a monkey appears in the musical scene, might also feature folk music. Only 1 and 2 are depictions of the official music.

4.4 Identifications:

Identifying the instruments in this period is more difficult than in other periods because most ensembles depicted feature folk music with lutes, small lyres, and small drums. The literary texts, apart from the Šulgi hymns, lack any words for lute and have no references to folk music ensembles.

The only depictions of cultic music (1) show a vertical harp and a singer (?), and a big drum and clapping sticks (2). In the descriptions of cultic music the combination most often mentioned is tigi, ala and šim. In 3.4 I have suggested that tigi be identified with the big lyre. That identification could still be valid for the O.B. period, since a picture of a big lyre is drawn on terracotta plaques (tab. 2.3 0 R 78-79). The word balaĝ, sometimes replaced by the more specific terms balaĝdi or ĝišgudi, is to be identified with the vertical harp. Although alĝar 'horizontal harp' and miritum 'small Syrian lyre' (type B) are mentioned among the ensemble instruments, they do not occur in the iconography of the late 3rd millennium.

5. Musical instruments from the 1st millennium B.C.

5.1 Musical instruments in the lexical lists of the 1st millennium B.C. (tab. 3.1).

The lexical tradition of the late 2nd and 1st millennium is primarily based on the series of O.B. lexical lists. The number of musical instruments on these lists expands gradually from the O.B. period, as can be illustrated by the evolving text of Hh.

OB Hh entries	MB Hh entries	NB Hh entries
23	29	76

The M.B. Hh has a few extra synonyms for individual musical instruments but is not so different from the O.B. version. It also adds zannaru (= ĝiš za.dINANNA) 'Anatolian lyre', and ĝišdìm.(mar.kur₄.ra/mar.ha.ši) 'Iranian (from Margiana/Fars) type of lute' (?), items known from the O.B. Šulgi hymn B. Middle Babylonian Hh merges the section ala with that of alĝar, writing it as á.lá.kara₂(!), possibly because of assonance between ala and alĝar.

The standard version of Hh VII (B) has many extra entries. Most involve synonyms or parts of the musical instruments or associations with other instruments. As such they can be seen as a commentary on the entries in the earlier versions, to be compared with the commentary series Hg, where Akkadian synonyms and other associations are included.

5.2 Musical ensembles in the literary texts of the 1st millennium B.C. (tab. 3.2)

• Chordophones, aerophones, and percussion: 2, 4, 8, 10.
• Chordophones and percussion: 3, 6, 9, 11.
• Chordophones: 1, 7.
• Aerophones and percussion: 12.
• Percussion: 5.

The chordophones mentioned in the literary texts include the previously mentioned balaĝ, balaĝdid, ĝišgudid, harhar, sabitum, tigi, zamin and a new term, ṣibattu. gisug is an aerophone that occurred earlier, but gigid/*ariktu* and *kanzabu* are new in the lists. As well as ala, meze, šim/ub again among the percussion instruments we find the new terms lilis, papa, papa epan.

Apparently the alĝar and the alĝarsur are no longer used, although they are still mentioned in lexical lists. For the rest tigi is found in lexical texts as a musical instrument (CAD T: 398). In literature tigi occurs only in the balaĝ-hymn Uru amirabi, which is attested in an O.B. version, so it must be regarded as antiquarian. The sabitum/*šebītu* appears (only once) among other chordophones (balaĝ, zamin), aerophones (*arkātu, kanzabu, malīlu*) and percussion (*ṣinnitu*).

The standard cultic ensemble consists apparently of balaĝdi, meze and šim/ùb. balaĝdi can alternate with ĝišgudid or balaĝ, as in the O.B. period (tab. 4.2.1-3). Even in this period it is highly unlikely that ĝišgudid can be identified with the lute, since it is always mentioned in the context of official music (4, 7).

Examination A (1), like the hymn B of Šulgi,

is comparable with the lexical lists, accumulating the names of individual instruments, the chordophones, in a particular sequence. Another special case is Šurpu III 88-91 (10), a text which concerns liberating from the effect of oaths sworn in front of different musical instruments, which are listed in groups of two or three: *mazzû - lilissu* (percussion) line 88: *halhallatu - tāpalu* (percussion) line 89: *alû - palaggu - timbūtu* (chordophones) line 90: *sammû* ([giš]*zà.mí*) *- ṣibattu* (chordophones ?) line 91.

5.3 Musical ensembles occurring in 1st millennium iconography (tab. 3.3.1-2)

• Chordophones (small lyre), aerophones (double pipe type A) and percussion (small drum): 3.

• Chordophones (small lyre), aerophones (double pipe type A), and singers (people clapping+singers): 10.

• Chordophones (horizontal harp+small lyre, horizontal harp+small lyre) and aerophones (double pipe type A-B): 6, 12.

• Chordophones (small lyre 2 types, 4 horizontal harps), and percussion (small drum, small drum + cymbals): 1, 8, 9.

• Chordophones (2 horizontal harps, 3 small lyres): 5, 7, 11.

• Aerophones (ram's horn, double pipe) and percussion (big drum, small drum+pithyra): 2, 4.

On reliefs from north-western Syria (1, 2, 3) cultic ensembles are shown with various combinations of small lyres (two types), percussion (small and big drum), and aerophones (double pipe (A) and ram's horn). An ivory box from Nimrud in Syro-Phoenician style (4) can be regarded similarly. The orchestras on the reliefs of the Assyrian palaces are different. After his successful lion hunt the king is attended by two musicians holding horizontal harps, in relief 5A, B, C.11

Several reliefs depict music in a military situation. An interesting scene of music and dance after the defeat of the enemy can be seen in table 3.3.1 5D. Two harpists and a drummer appear at the right and on the left side there is a lute player with masked dancers. This is comparable to the garden scene following Assurbanipal's defeat of Te'umman of Elam (12) with its ensemble of vertical and horizontal harpists and someone playing the double pipe. After their victory at the river Ulay (10) the troops are welcomed by a full orchestra with horizontal and vertical harps, double pipes, clapping and singing (twittering ?) women and children. A smaller ensemble, with two small lyres, cymbals and a small drum encourages the troops in battle (9). Lyre ensembles from outside Assyria were conscripted to play for the Assyrians (7).

There are other palace ensembles apart from these military scenes: a small lyre, harp and double pipes, played by women (?) (6) and a musical ensemble in a garden with a small lyre, played by an Elamite musician with a feather

headdress, behind a horizontal harp played by a woman (11). The temple orchestra on a relief from the palace of Sennacherib (8) apparently consists of horizontal harps, small drums and cymbals. The fish-like headdresses of the musicians playing the horizontal harps point to their official positions as incantation priests. Two types of double pipe can be distinguished: A, with two diverging tubes, and B, with parallel tubes.

5.4 Identifications

It is tempting to identify the instruments of the standard cultic ensemble, balaĝdi, meze and šim/ùb, with the temple ensemble of horizontal harps, cymbals and small drums (tab. 3.3.2 8), but that is not very convincing in view of earlier identifications. It is unreasonable to expect, the meaning of balaĝdi to have developed between the 2nd and 1st millennia from a vertical to a horizontal harp, especially when *šebītu*, a type of horizontal harp in the O.B. period, is mentioned among other instruments (tab. 3.2 8). It is better to consider balaĝ, balaĝdi and also ĝišgudid as terms for vertical harps which are found in several ensembles (tab. 3.3.2 6, 10, 12). The small lyre is apparently the zamin. The double pipe type A could be the gisug/*malīlu* and type B the gigid/*ariktu* 'long reed', since it has long tubes. šim/ùb must be the small drum. It seems unavoidable to equate meze with the cymbals, but because sistra, the proposed identification of meze, are not found in 1st millennium iconography some hesitation is justified.

6 Conclusions:

1. The ensembles of the first half of the 3rd millennium contain vertical harps (balaĝ), with big lyres (tigi), small lyres (zamin) and singers (nar, endu).

2. After 2300 B.C. the ensembles slightly change possibly under the influence of Northern Mesopotamia caused by the coming of the Sargonic dynasty. The standard ensemble of cultic and official events consists of big lyres (tigi), small Syrian lyres (balaĝ mari, miritum), harps (balaĝ, balaĝdid, ĝišgudi), horizontal harps (alĝar), big drums (ala), kettledrums (lilis), small drums (šim) and clapping-sticks (adab).

3. The ensembles of the early 2nd millennium continue the tradition of the late 3rd millennium but supplemented with the imported horizontal harp (sabitum), the flute (gisug) and the cymbals (meze). Innovation in the realm of folk music involved playing some foreign instruments such as lutes. At least in Mesopotamia they did not find their way into official performances.

4. The 1st millennium ensembles remained traditional. As the main instruments of the cultic ensembles they maintained the vertical harp (balaĝdid), the (Iranian) horizontal harp (sabitum), the small lyre (zamin), sistra (meze), kettledrums (lilis) and small drums (šim). After the O.B. period the big lyre (tigi) became obsolete.

5. Generally speaking Mesopotamian ensembles are conservative in their combinations of chordophones,

aerophones and percussion instruments. Within these groups newer instruments are only introduced to replace older ones.

Illustrations and tables of musical instruments.

Fig 1. Development of the sign BALAĜ from the Late Uruk to the Fara period.[12]

ZATU 47 (± 3200 B.C.)

ZATU 47 (± 3000 B.C.)

LAK 41 (± 2600 B.C.)

LAK 387 (± 2600 B.C.)

Rosengarten no. 163 (± 2200 B.C.)

Schneider no. 518 (± 2000 B.C.)

Fig 2: Development of the sign ŠIM "drum" from the Fara to the Ur III Period.

Table 1.1. Musical instruments in the lexical lists of the 3rd millennium B.C.[13]

Instrument	Classification	1 ED Lu A (Enlund)	2 ED Lu B	ED Lu C	3 ED Lu E	4 EDPV A	5 EDPV B	6 Other Word Lists: SF No.	7 Sign Lists: SF No.	8 NPL	9 VE	10 EV
balaĝ (gal.balaĝ sa.balaĝ)	C	106 (gal)				206	XII 11 (sa)	45 II 3	7 II 18; 62 III 9; 69 IX 7-14	210	364; 1242	
balaĝdid	C		8		98						571	
balaĝdilmun	C					207						
balaĝmari	C					208						
burbalaĝ	C			23	104	211						
tigi	C						V 6					
za(min)	C	108 (?)									(1181)	
gidid	A				102	209					218; 1390	d 36; g 7
gisug	A				103 (B)							b 42
gitag	A				104 (B)	210 (A,C)					1230 (B)	
siamsi	A					215						
ala	P				101							
ĝištag	P					212						
ruru	P					214						
šim/ub(tak)	P					213 (tak)						
zam(zam)	P				99							
nar (gal.nar)	S	81b; 105 (gal)	10	21	27; 94;			V 1-11			875	
šir	S			22	107							
šud	S				110-111 (ama)					198; 223		

Table 1.2. Musical ensembles in the literary texts of the 3rd millennium B.C.[14]

	Classification	Amaušumgal	IAS No. 116 6 19; 318 2 1	Gudea: Cyl A VI 24-25 // VII 24-25	Gudea Cyl A XVIII 18	Gudea Cyl A XXVIII 17-18	Gudea Cyl. B X 9, 11	Gudea Cyl B XV 18, 20-21
alĝar	C						+	
balaĝ	C			(+)		+		
balaĝdilmun	C		(+)					
ĝišgudid	C			(+)				
miritum	C						+	
tigi	C	(+) (B, C)					+	+ (C)[1]
adab	P				+			
ala	P				+	+		+
šim/ub	P				+ (B)	+ (B)		+ (B)

Table 1.3.1. Musical ensembles (instruments) excavated or occurring in 3rd millennium iconography (1).

Object	1 Cylinder Seal (Choga Mish)	2 Chlorite Vessel (Adab import)	3 Vase Khafaji	4 Votive plaque (Khafaji)	5 Votive plaque (Nippur)	6 Standard Peace Side (Ur)	7 Tomb PG 1237 (Ur)	8 Tomb 121198 (Queen Pu-Abi) (Ur)	9 Tomb PG 789 Lyre: Animal Orchestra (Ur)	10 Tomb PG 333 (Ur)	11 Cylinder Seal: Animal Orchestra
date	3100	2800	2800	2600	2600	2500	2500	2500	2500	2500	2500
literature[1]	Z p. 6	R. p. 56[2]	Z. p. 7	R. 32-35; Z. p. 10	R. 36	R. 11-12	R. 1	R. 9-10, p. 42	R. 8	R. 13-14	R 30
horizontal harp		+ (2)									
vertical harp	+			+			+	+			+
big lyre			+				+ (2)	+	+		
small lyre type A					+	+	+ (1)[3]				
small lyre type B											
lute											
flute										(+)	
ram's horn trumpet		+			(cf R 37)						
big drum	+		+								
small drum		+									
sistrum									+		
clapping sticks	+										+
people clapping								/ + (7 ?)			
singer	+ ?	+ (1) ?		+ (1) ?	+ (2) ?	+	+ (3) ?	/ + (7 ?)			

Table 1.3.2. Musical ensembles (instruments) excavated or occurring in 3rd millennium iconography (2).

Object	12 Cylinder Seal (Mari)	13 Cylinder Seal B 390	14 Cylinder Seal B 385 (AO 2371)	15 Cylinder Seal B 676 (Coll. Erlenmeyer)	16 Cylinder Seal B 385 (IM 33287)	17 Cylinder Seal B 497	18 Cylinder Seal B 507	19 Gudea Stele (Fragments) (Ĝirsu)	20 Ur-Namma Stele (Ur)	21 Votive plaque (Susa)
date	2500	2300	2250	2250	2250	2250	2250	2150	2100	2000
literature	Z p. 33	R 44	R 42	R 43	R 41	R 38	R 39	R 45; p. 70; 51-52[1]	R 53-56	Z p. 14
vertical harp	+	+								+
big lyre			+					+		
small lyre Type A					+					
small lyre Type B				+						
lute						(+)	(+)			
flute										
ram's horn / trumpet										
big drum								+ (2)	+ (2)	
small drum								+ (2)	+ (2)	
sistrum			+							
clapping sticks	+	+								
people clapping	+							+ (2+)	+ (2+) ?	
singer	+ (3)			+ (?)	+ (?)					+ ?

Table 2.1 Musical instruments in the lexical lists of the 2nd millennium B.C.

		1	2	3	4
Instrument	Classification	OB Hh I (ĝiš 'wood')[1]	OB Hh II (gi 'reed'; kuš 'hide, leather'; zabar 'bronze'[2]	OB Proto-lu	OB Lu.aslag$_2$
alĝar	C	I 601			
alĝarsur	C	I 602			A 248 (B)
balaĝ	C	I 597-599	II C 135 (kuš)	660-662	A 250
balaĝdid	C	I 598 (A)	II C 136 (kuš C)		A 252-253 (A); 250 (C); 251 (D)
dua	C	I 618		640 (ĝiš)	
ĝišgudid	C	I 617		639	
harhar	C	I 607			
miritum	C	I 604			
niĝharmušen	C	I 608			
sabitum	C	I 603			
šukara (šu)	C	I 619 (620)		640a	
tigi	C			(643)	
tigidla	C	I 613-616 (kaskal; sa.3, Elam.ma)			
urzababa	C	I 605			
urgula	C	I 606			
zamin	C	I 610-612	II C 138 (kuš)		
gidid	A				A 242; 244
gisug	A		II A 104 // 121a		A 243 (A)
adab	P			612a	
ala	P	I 600	II C 137 (kuš)		A 247 (A)
meze	P		II D 33 // 57b (zabar)		
lilis	P		II D 34 // 57a (zabar)		
šim/ub	P	II 565	II C 136a-b (C) // 139-141 (C) (kuš); II D 32 (zabar) (F)		
zamzam	P/A (?)			619	
adša	S			604-605	
endu	S			600-603	
gala	S			653-658	
iludid	S				A 245-246
nar (gal.nar)	S			641-650	
šir	S			587-599	
širsaĝ	S				A 255-256

Table 2.2.1. Musical ensembles in the literary texts of the 2nd millennium B.C.(1)[22]

Instrument	Classification	1 — Al-apin 27-28	2A — Curse of Akkade 35-38	2B — Curse of Akkade 200-204	3A — Enki's Journey to Nippur 62-71	3B — Enki's Journey to Nippur 93-95	4 — Enkitalu and Enkihegal 113	5A — Iddin-Dagan A 35-36; 41-42	5B — Iddin-Dagan A 79	5C — Iddin-Dagan 1 (A) 204-207	6A — Inanna and Enki II iv 46-48	6B — Inanna and Enki II vi 25
alĝar	C				+			+		+		
alĝarsur	C		+		+							
balaĝ	C			+ (7)	+			+				
balaĝdid	C											
(dim)	C											
ĝišgudid	C									+		
harhar	C				+							
miritum	C				+							
sabitum	C				+							
siezen	C											
(šukara)	C											
tigi	C		+		+ (7)		+		+		+	+
(urgula)	C											
(urzababitum)	C											
zamin	C									+		
(zannaru)	C											
adara	A											
gisug	A		+									
adab	P						+					
ala	P	+				+			+		+	+
lilis	P			+				+				+
meze	P			+								+
šim/ub	P	+		+	+ (zabar)	+			+		+	+
zamzam	P		+		+							
papa	P											
gurtur	?											
malgatum	?											

Table 2.2.2. Musical ensembles in the literary texts of the 2nd millennium B.C.

Instrument	Classification	7 SEM58 372 / Mariage of Martu I 11	8 Lamentation over Nippur 38	9 Lamentation over Sumer and Ur 436	10 Lamentation over Ur 356	11 Lamentation over Uruk 12.16-18	12 Nanše-hymn A 40-44	13 Nisaba-hymn A 34-35	14 Summer and Winter 235-237	15A Šulgi A 53-54	15B Šulgi A CC IV 23-24 (Susa)	16 Šulgi B 157-172
alĝar	C											(+)
alĝarsur	C											
balaĝ	C						+					
balaĝdid	C										+ (/ tigi)	
dim												(+)
ĝišgudid	C								+			(+)
harhar	C											(+)
miritum	C											(+)
sabitum	C											(+)
siezen	C								+			
šukara												(+)
tigi	C	+		+		+	+	+	+	+		(+)
urgula												(+)
urzababitum												(+)
zamin	C											(+)
zannaru	C											(+)
adara	A						+					
gisug	A							+				
adab	P											(+)
ala	P	+	+	+	+	+			+	+	+ (B)	
lilis	P											
meze	P											
šim/ub	P	+	+	+	+	+			+	+	+ (D)	
zamzam	P							+	+			
papa	P											
gurtur	?						+					
malgatum	?											

Table 2.2.3. Musical ensembles in the literary texts of the 2nd Millennium B.C. (3).

Instrument	Classification	17 Šulgi C b 76'	18 Šulgi D 366-367	19A Šulgi E 22	19B Šulgi E 53-56	19C Šulgi E 101-102	20 TH 106-107	21 Urnamma A 187	22 Ziegler p. 13: RIME 4.11.2.2[1]	23 Ziegler nr 41
alĝar	C									
alĝarsur	C									
balaĝ	C					+				
balaĝdid	C									
dim										
ĝišgudid	C									
harhar	C									
miritum	C									
sabitum	C									
siezen	C	(+)								
šukara		(+)								
tigi	C	(+)	+	+	+			+	+ (100)	
urgula										
urzababitum										
zamin	C									
zannaru	C									
adara	A									
gisug	A							+		
adab	P	(+)		+	+			+		
ala	P		+				+			
lilis	P									
meze	P									
šim/simda sim	P		+			+ (simda)				
ub	P						+			
zamzam	P							+		
papa	P									+ (several)
gurtur	?									
malgatum	?	(+)		+	+					

Table 2.3. Musical ensembles occurring in the 2nd millennium iconography.

Object	Classification	0 (As only instrument depicted)	1 Terracotta relief (Larsa)	2 Stele (Ebla)	3 Terracotta relief IM 32062 with monkeys (Larsa)	4 Terracotta relief AO 16924 (Larsa)	5 Terracotta relief VA 7224 (?)	6 Cylinder seal (?)
date			1800	1800	1800	1800	1800	1300
literature			O 603	Z, p. 31	R 57	R 57	R 57	R 107
horizontal harp	C	R 71-74 (A) R 75 (B)						
vertical harp	C		+					
big lyre		R 78-79						
small lyre	C						+	+
lute	C				+ (2)	+		+
flute/oboe	A	R 88-89						
ram's horn / trumpet	A	R 85-87, 90						
big drum	P			+				
small drum	P					+	+	
sistrum	P							
clapping sticks	P			+				
singer	S		+		+ (2)			

Table 3.1. Musical instruments in the lexical lists of the 1ˢᵗ millennium B.C.

Instr.	Classific.	1 MB Hh	2 Hh VIIB	3 Hh IX (ĝi) Hh XI (kuš)	4 Hg	5 Diri III
alĝar	C	4247 (á.lá. kara2!)	57/63-67			
alĝarsur = *algarsurû*	C	4248 (á.lá. kara2.ùr)	59-61; 68-73		B 165 B 166 (ĝⁱˢsur9. ra); B 167 (ĝⁱˢsur9.gal);	
balaĝ = *palaggu*	C	4244	39	XI 265		
balaĝdid = *timbutu*, *telitu*, (*tukkannu*, *utemenakku*)	C	4245	40-43	XI 266-267; (Canonical lú IV 175)	B 161 (utemenakku)	
dìm (markurra/marhaši)	C	4262-4263	48			
dua	C		126			
ĝišgudid = *inu*	C	4270	117, (118-131), 133-134		B 172 (ĝiš.gal.30.àm); 173-174 (ĝⁱˢgù.dé.šà.ulu₃. ša4.(gú.ĝar.ra)	
harhar = *harharu*	C		55-56		B 163-164	
(níĝ)harmušen	C	4254-4256				
mandi = *mandiu*	C					53 ĝⁱˢŠU.ĜAL₂
miritum	C	4251 (maritum)	77-78			
sabitum = *šebitu*	C	4249-4250 (*šebitu*)	74-76			51 ĝⁱˢBALAG. TUR
sa'uš	C	(4267)	86a		B 171 (ĝⁱˢsa.3)	
ṣibatu	C (?)					
tigi = *tigû*, *habṣillatu*	C			(Canonical lú IV 226)	(uruda) 194	
tigidla = √*tigidlû*	C	4264-4268				54-56 ĝⁱˢŠA3. MIN.DI/ TAR/ KASKAL
tungal = *tungallu*	C				B 168	ĝⁱˢ ᵈEN.KI/ZU 47-48
urgula	C	4261	85			
urzababa= *urzababitum*	C	4252	79-85		B 169	ĝⁱˢ ᵈNIN.URTA 49
zamin = *sammû*	C	4257a-4260	44-54		B 162 (zà.mí.si. sá)	52 ĝⁱˢAR₂.RE
zannaru = *zannaru*, *kinnaru*, *kandabitum*, *tindû*, *harhadû*	C	4253a-c	(86a-b		B 170 (ĝⁱˢdim. nun)	43-46 ĝⁱˢZA. MUŠ3
adara	A					
bún	A (?)	4269				
gidid (var.: gi.gù.nun.di.d)	A			IX Gap D c 1-3: var.	38 (var. +balaĝ)	
gigid = *arkatu*	A					
gisug = *malîlu*	A			Gap 2 = IX Gap D b 1-2	36-37	
adapa	P				(uruda) 193	
ala = *alû*	P	4247	62	XI 269		50 (BALAG. TUR)
kanzabu	P (?)					
meze = *mazû*	P		not in Hh			
lilis = *lilissu*	P		not in Hh			
PAPA = *ṣinnatu*/ *ṣinnitu*	P (?)		115			
PAPAepana = *tâpalu*	P (?)		116			
šim/ub = *halhallatu*	P				208	
zamzam = *samsammu*, *lilissu*	P		279		(uruda) 191-192	

Table 3.2. Musical ensembles in the literary texts of the 1st millennium B.C.[24]

Instrument	Classification	1 Examanation A 28	2 Balaĝ Utu … ekura a +36-41	3 Balaĝ Uru amirabi	4 Eršemma No 159 17-23	5 Eršahuĝĝa nr 1 22	6 KAR 119 (Akk)	7 SAA 3 nr 2 28 (Akk)	8 SAA 3 nr 4 I 7-9 (Akk)	9 Šurpu III 37 (Akk)	10 Šurpu III 88-91 (Akk)	11 BBSt nr 35 rev. 2 (Akk)	12 LKA nr 70 21 (Akk)
Language		Sum - Akk.	Sum – Akk (partly)	Sum –Akk (partly)	Sum	Sum - Akk	Sum - Akk	Akk	Akk	Akk	Akk	Akk	Akk
balaĝ = palaggu	C		+ (3)		+				+		+		
balaĝdid = timbuttu	C	(+)	+	+			+			+	+		
ĝišgudid = inu	C	(+) (B)			+			+				+ (B)	
harhar	C	(+)											
sabitum = šebitu	C								+				
ṣibâtum	C (?)										+		
tigi	C			+									
zamin = sammû	C	(+)						+	+		+	+	
gidid	A				+								
(gierra)	A	only isolated											
gigid = arkâtu	A		+						+				+ (?)
gisug = malilu	A								+				+ (?)
ala = alû	P			+ (A)							+	+	
kanzabu	P (?)								+				
lilis = lilissu	P		+ (B)								+		
meze = mazû	P		+		+	+					+		
papa = ṣinnatu	P								+				+
papa epan = tâpalu	P									+	+		
šim = ḫalḫallatu	P		+ (A)		+ (F)		+				+		
ub (= kuš/uruda ub) = uppu	P		+ (A)		+ (A)	+							

Table 3.3.1. Musical ensembles occurring in 1st millennium iconography (1).

Object	Classification	1 Relief (Šam'al)	2 Relief (Carchemish)	3 Relief. (Karatepe)	4 Ivory box (Nimrud)	5 A-B-C Relief. Palace of Assurnasirpal BM 124533 // 124535 // 124886 (Nineveh)	5 D Relief.Palace of Assurnasirpal BM 124548 (Nineveh)	6 Relief. Palace of Sennacherib BM 124922 (Nineveh)
date		900	800	700	800	875		700
literature			Z. p. 71		R. p. 108+122	R 134 (A) // 135 (B) // 146 (C)	R 136-137	145
horizontal harp	C					+ (2)	+ (2)	
vertical harp	C							+
small lyre	C	+ (2 types)		+ (2 types)				+
lute							+	
double pipe: type A -B	A			+ (A)	+ (2) (A)			+ (1) (A) + (2) (B)
ram's horn / trumpet	A		+					
big drum	P		+					
small drum	P	+ (2)		+	+		+	
cymbals	P							
chalcophone	P				+ (2)			
people clapping	S						+ (dancers with mask)	
singer	S					(+ ?)		

Table 3.3.2. Musical ensembles occurring in 1ˢᵗ millennium iconography (2).

Object	Classification	7 Relief. Palace of Sennacherib BM 124947 (Nineveh)	8 Relief. Palace of Sennacherib BM 124948 (Nineveh)	9 Relief. Palace of Assurbanipal AO 19908 (Nineveh)	10 Relief. Palace of Assurbanipal BM 124802 (Nineveh)	11 Relief. Palace of Assurbanipal BM 118916 (Nineveh)	12 Relief. Palace of Assurbanipal BM 124920 (Nineveh)
date		700	700	650	650	650	650
literature		142	p. 122 +141	149-150	151-153	148	147+ p. 126 (?)
horizontal harp	C		+ (4)		+ (2)	+	+ (1+)
vertical harp	C				+ (7)		+ (1+)
small lyre	C	+ (3)		+ (2 types)		+	
double pipe: type A -B	A				+ (2) (A)		+ (B?)
ram's horn / trumpet	A						
big drum	P						
small drum	P		+ (2)	+			
cymbals	P		+	+			
chalcophone	P						
people clapping	S				+ (2+9) + (2) lamenting		
singer	S				+ (2) (twittering)		

Glossary of musical instruments and their writing.[25]

1	2	3	4
adab	a.da.ab (A); a.dab$_6$ (B); (uruda)a.da.pà (C)	P: M	'standing beside or on top of each other' (A, B), 'resounding together' (C) = clapping-sticks (?)[26] It is also a type of song. For the determinative sign uruda "copper, metal" see ^{uruda}a.da.pà = adapu = mazzû Hg to Hh XI 193 (Landsberger, *MSL VII*, 153). The equation with mazzû/manzû (= mezé) "jaw, sistrum" points to a metal idiophone (see U. Gabbay in this volume).
adara	á.dara$_3$	A	'horn of the ibex'.
adša	ad.ša$_4$	S	'uttering a soft sound' a type of singer.
ala	$^{(ĝiš/kuš/uruda)}$á.lá (A) / a.la (B) = alû (C)	P: M	'(instrument) fastened to/suspended from the arm'. ala is listed directly after balaĝ and before alĝar in OB Hh (I 600). In canonical Hh VII B 62-73, between alĝar and sabitum it is associated with alĝar (see there), balaĝ.gal 'big harp/instrument', balaĝ.tur 'small harp/instrument', TUN$_3$.gal 'big bag' = tungallu 'big bag' = tukkan ša nukuššê 'bag of the doorsil'. These explanations all point to an instrument with a substantial sound box ('big bag') and a pole standing horizontally in a hole or an instrument resembling the 'bag of the doorsil'. Ziegler, N. (Musiciens Mari, pp.74-6) has demonstrated that it was a heavy instrument sometimes made of copper, which makes the identification with the big drum certain. This being so, the association with the alĝar etc. in MB Hh Can. Hh VIIB 63, is somewhat peculiar. The gods Enki and Sîn are connected with the ala in Can. Hh VII B 72-73. alû forms a trio with palaggu and timbûtu in Šurpu III 90 (Table 3.2 10).
alĝar	$^{(ĝiš)}$al.ĝar	C	'(instrument) placed down'. ^{giš}al.ĝar occurs in Ur III-Early OB administrative texts from Isin. The fact that the alĝar is listed among the stringed musical instruments, *e.g.,* MCS 5 115 No. 1 6 (administrative Isin) and its playing technique is indicated with aga.šu.si 'fingering' (Krispijn, 'Beiträge', pp.10-1) makes an identification with a chordophone more likely than with a type of drum.
alĝarsur	$^{(ĝiš)}$al.ĝar.sur$_9$ (A); al.ĝar.su.ra (B) = algarsuru (C)	C	'(instrument) placed down with a plectrum'. Can. Hh VII B 60-61 lists two regional types including an Elamite type of alĝarsur. In Hg B II 165 algarsurrû is equated with šulpu ša balaĝ (!?) 'stick of the musical instrument' = plectrum (?) and surgallu with šulpu 'stick'. Veldhuis, N. ('The sur$_9$-Priest, the Instrument ^{ĝiš}al.ĝar.sur$_9$, and the Forms and Uses of a Rare Sign', AfO 44-45 (1997-1998), pp. 119-128) considers the ^{ĝiš}al.ĝar.sur$_9$ to be a drumstick; see also Shehata, D. N. ('Some Observations on the /alĝarsur/', in Gatsov, I. - Schwarzberg (ed.), Aegean - Marmara - Black Sea: the Present State of Research on the Early Neolithic (Langenweissbach 2006), pp. 367-378). For my reasons for considering the alĝarsur to be a stringed musical instrument see alĝar.
balaĝ	$^{(ĝiš/kuš)}$balaĝ= palaggu (B)	C	'harp' (?). The pictogram for balaĝ develops from a bow-shaped chordophone (Uruk ± 3200 BC) into an angular-shaped harp (Fara ± 2600 BC, see fig.1). Composites of balaĝ in the early lexical lists of professions are: gal .balaĝ 'leader of the balaĝ-players'; balaĝ.did (see balaĝdid); NAR.BALAĜ (see tigi). Later balaĝ might have been developed into a term for a musical instrument in general. ^{ĝiš}balaĝ occurs in Ur III administrative texts from Ur, Isin and elsewhere. *Cf.* balaĝ = kinnārum 'Syrian lyre' VE 572.[3] palaggu forms a trio with alû and timbûtu in Šurpu III 90 (Table 3.2 10).
balaĝdid / dubdu	$^{(ĝiš/kuš)}$BALAĜ.DI (A) = dubdu (?) = timbûtu (B); BALAĜ.di.da (C); BALAĜ.BALAĜ.di = dúb.dúb.di (D)	C	'sounding balaĝ' (?) also 'harp player, singer of balaĝ-songs'. For the pronunciation of BALAĜ.DI as dubdu(b), see Krispijn, 'Beiträge', p. 23 note 40. In Can. Hh VIIB it is equated with utemenakkum < *ù+temen+ak 'plank/bridge of the (foundation) peg(s)', which could point to the side of a harp with tuning pegs. Hg B II 161 explains that word as kiṣallu 'ankle bone'. The sign BALAĜ and cognates have the readings balaĝ, dúb and tak$_x$. dubdub(di) (D) is a reduplicated, onomatopoeic (?) form like ḫalḫallatu, lilis and zamzam. timbûtu or timbuttu forms a trio with alû and palaggu in Šurpu III 90 (Table 3.2 10).

balaĝ dilmun	balaĝ.dilmun = *talmuttu* (?)		'balaĝ of Dilmun'. Dilmun is the region from the island Failaka as far as Bahrain (including the opposite coast). In MB Hh 4266-4267 *talmuttu* 'instrument of Dilmun', occurring in OB Mari as well (CAD T, p. 414, but there not understood as 'Dilmunite'), is used for a type of lute.
balaĝ mari	balaĝ.ma.rí = *miritum*		'balaĝ of Mari'. Mari is an important city state on the Middle Euphrates on the way to Syria. The 'harp of Mari' is the precursor of *miritum*.
burbalaĝ	búr.balaĝ	C	búr.balaĝ special type of balaĝ or 'balaĝ-player moving (his fingers ?) quickly'. Cf. nundum.nundum.búr.ke$_4$ = *šaptân muṣṣabrâtum* 'twittering lips' CT 17, 32 19-20; nundum.búr.re.balaĝ.ĝá = *nasâsum* 'to wail' Kagal D sect. 9 7 (PSD B, 195-196).
dim	$^{\text{ĝiš}}$dìm	C	'pole'. Two regional types are attested: $^{\text{giš}}$dìm.mar.kur$_4$.ra = *ḫalmatru* 'pole from Margiu/Ḫalmatru' (MB Hh 4262) // $^{\text{ĝiš}}$dìm.dìm.addir 'poles of the bridge' (Can. Hh VII B 48); and $^{\text{ĝiš}}$dìm.mar.ha.a.ši = *paraḫšû* 'pole from Fars' (MB Hh 4263) 'pole of Margiu/Ḫalmatru'. The Akkadian translation in Hh VII B 48 and Hg B I 191: *sagû=arkilla* 'bear' (?) is unclear. Possibly it is a kind of lute.
endu	èn.du	S	'uttering a humming sound' èn is onomatopoeic for a humming sound.
gala	gala (UŠ.KU)	S	Possibly a loanword from Semitic *qr'* 'to call, recite' (?) = lamentation singer, cult singer. The early writing UŠ.KU.e.ne = *gala'ene in the inscriptions of Urukagina (Ukg 6 I 13') confirms an original hiatus at the end of the word.
gi'erra	gi.ér.ra	A	'reed of weeping'.
gidid	gi.di (A); gi.di.da (B) =	A	'sounding reed'. gi.di = *raḫâlu* gi; *bariṣum* 'to bleat of a reed'; 'hollowed out', *cf*, Krispijn, 'Beiträge', p. 15, Civil, Practical Vocabulary A, p. 100.
gigid	gi.gíd.(da) = *arkâtu* (?) (B)	A	'long reed'. A complication is that both su$_{13}$ and gíd are written with the sign BU.
gisug	gi.su$_{13}$ (A); gi.sù (B) = *malîlu* (C)	A	'empty reed'. Krispijn, 'Beiträge', pp. 15-17: BU=su$_{13}$ an earlier writing for sù.(ga) 'empty, hollow'.
gitag	gi.tag (A); gi.tak$_4$ (B); GIxTAK$_4$ (C)	A	'played reed'. tag or tak$_4$ might be earlier writings for TUKU/du$_{12}$ 'to play an instrument'. (Civil, *Practical Vocabulary* A, p. 101).
gurtur	gur.tur	?	'small basket' (?).
gusala	gú.sa.lá	C	'neck, to which strings are attached' directly after šukara in OB Lú 640a.
ĝišdua	$^{(\text{ĝiš})}$dù.a	C (?)	'erected/planted wood/tree' or 'provided with a penis'. $^{\text{ĝiš}}$dù.a = *karna inu, karnânu* is apparently synonymous with $^{\text{ĝiš}}$šu.kara$_2$. See also ĝišgudid.

ĝišgudid	ĝiš.gù.di.d (A); gù.dé (B)= *inu* (C)	C	'loudly sounding wood'. Epithet of various instruments. In Can. Hh VII B 117-132 ĝišgudid is associated with kiri₆ 'garden' (118); ù.lu.di 'tinkling' (119); du₈.du₈ 'richly provided with' (120); šu.galam.ma 'stairs (?)'[29] (121); sa.šú 'casting net'(122). All these entries could be similes of a many stringed chordophone like the harp. That is confirmed by the entry 132: ĝiš.gal.30.àm 'big wooden (instrument) with 30 (strings)'. The known parts of the ĝišgudid are: úr 'base'(123); u₅ 'summit'(124); ĝiš.dù.a 'supplied with a penis'[30] (126); ĝiš.dím 'carved wood' (127); ĝišbala 'spindle' (128); á.ĜA₂ 'arm of the ...' (129). In 130-131 the *inu* has the Sumerian equivalents ĝiš.gal 'big wooden (instrument)' and ĝiš.šu.gal 'big wooden hand'. Otherwise its position in OB Hh I between tigidla and šukara, two types of lutes, makes it more likely to interpret ĝišgudid as a lute from the OB period onward (see A.D. Kilmer, 'Laute. A. Philologisch', *RlA* Band 6, 512-515 (Berlin, 1983).
ĝištag	ĜIŠxTAK₄ (A); ĝiš.tag (B)	P: I (?)	'wood played on'. 'ĝištag', must be a type of wooden drum, *cf.* ĝiš.tag = NI-*bù-um* (=a/*uppum* ?) 'cylinder drum' VE 366; ĝišĜIŠxTAK₄ = *a-ša-ru₁₂-ru₁₂-um* (as/*šarru*) 'cylinder (?)' VE 437[1].
harhar	(ĝiš)har.har	C (?)	'rings, links of a chain'. In MB Hh 4254 harmušen(na) 'ring of a bird' instead of harhar is attested, though translated with *harhu/arrum*. Part of is this instrument is ĝešpu₂.har.mušen (MB Hh 4255) 'circular handle of the *harharu*' = *mušelû* 'part to lift the instrument'.
iludid	i.lu.di	S	'uttering the ilu-sound'.
kanzabu	*kanzabu*	P: I ?	'fawning (instrument)' < *kuzzubu* 'to fawn' 'rattle' (?).
lilis	li.le.èš (A); li.li.is (B); AB₂xBALAĜ = lilis (C) = *lilissu* (D)	P: M	Reduplicated, onomatopoeic (?) form like dubdub (=balaĝ.di), *halhallatu*, and *zamzam*. On the well-known tablet from the Seleucid period O 175 (Thureau Dangin, *Tablettes d'Uruk TCL VI*, (Paris, 1922), No.47) a kettledrum is drawn with the caption lilis (C). *lilissu* forms a pair with *manzû* in Šurpu III 88 (Table 3.2 10).
malgatum	ma.al.ga.tum	(?)	'song/instrument from *Malgium*'. Perhaps an instrument or a type of song.
meze	me.zé = *manzû* (B)	P: M	'cheek bone' = sistrum (?) *manzû* forms a pair with *lilissu* in Šurpu III 88 (Table 3.2 10).
miritum	(ĝiš)mi.rí.tum (A); ma.rí (B)	C	'(instrument) from Mari'. In Can. Hh VII B 78 it is associated with ĝišgú 'the wooden neck', possibly referring to the 'neck' of the instrument. ĝišmaritum occurs in Ur III-Early OB administrative texts from Isin. The furniture term ĝišzà.mi.rí.tum 'side (in the shape of) the miritum' occurs in texts from Ur, Umma, Puziriš-Dagan and Nippur-Esagdana.
nar	nar	S	'singer'.
niĝhar-mušen	(ĝiš)níĝ.har.mušen	C (?)	'thing (= part) of the bird snare'.
papa	(ĝiš)pa.(pa) = *ṣinnatu* (B)/ *ṣinnetu* (C)	A (?)	'sticks'. The Akkadian word is also used for parts of a rein and bridle.
papa'epana	(ĝiš)pa.pa.é.pa.na = *tâpalu* (B)	P: I	'pair of sticks'. *tâpalu* forms a pair with in *halhallatu* Šurpu III 89 (Table 3.2 10).
parahšitum	*parahšitum*	C	'(Instrument) from Far(a)hšum/Fars' occurs in texts from Mari and Middle Babylonian Lexical texts from Emar.

ruru	$^{(ĝiš/uruda)}$ru.ru	P : I	'curved metal or wooden throwing stick' Cf. $^{ĝiš/uruda)}$ru.ru = *mar-ba-a* GN (?) VE 414.
saeš	$^{(ĝiš)}$sa.eš	C	'three strings' ^{ĝiš}sá.eš occurs in Ur III-Early OB administrative texts from Isin.
sabitum	$^{(ĝiš)}$sa.bí.tum = *šebitu* (B)	C	'(instrument) from Sabum' is in Can. Hh VII B 75-76 associated balaĝ.tur 'small instrument (harp)' and with ^{ĝiš}susbu 'purification priest' (= MUŠ-*gunû*.BU). 'the wooden neck' ^{ĝiš}sá.bí.tum occurs in Ur III-Early OB administrative texts from Isin.
siamsi	si.am.si	A	'horn = tusk of the elephant'.
siezen	$^{(ĝiš)}$si.EZEN	C	'bound horn'. Part of a šukara-lute. Also part of the harp? *Cf.* si.EZEN = *qarnânû, qarna-inû* 'horn of the lute' = fret/tuning-key (?) (Krispijn, 'Beiträge', 4-5 and Krispijn, T.J.H., 'Musik in Keilschrift', p. 466).
ṣibâtu	*ṣi-ba-a-te* (Var. *ṣi-bat-ti*)	C (?)	'?' *ṣibâtu* forms a pair with zamin in Šurpu III 91 (Table 3.2 10) and could therefore be a chordophone; percussion and chordophone combinations are found in Šurpu III 90: *alû - palaggu - timbûtu*.
šim(da)	AB$_2$+ŠA$_3$= šèm/ùb (A); si.im (B); $^{(kuš)}$ sim (C); ši.im (^{zabar}) (D) = *ḫalḫallatu* (E); AB$_2$+KARA$_2$ = šem$_5$) (F)	P : M	šèm^{zabar} OB (Forerunner) II 565. The reading and development of the sign AB$_2$+ZAG/TAK$_4$/ŠA$_3$ = šèm/ub$_{3/5}$ and its phonographically written si.im is complicated (see now Civil, *Practical Vocabulary A*, pp.101 and fig. 2). A special type of drum is AB$_2$+ZAG.tak$_4$. A problem is the writing si.im.da for the expected si.im in Gudea Cyl. B XV 20 and Šulgi E 101. The parallel passage in Gudea Cyl. A XVIII 18 has only si.im. Is si.im.da the complete writing? In 1rst millennium texts šèm = AB$_2$+ŠA$_3$ = *ḫalḫallatu* is distinguished from ^{kuš}ùb = uppu. *ḫalḫallatu* (E) is a reduplicated, onomatopoeic (?) form like dubdub(di) (= balaĝ.di), lilis and zamzam. *ḫalḫallatu* forms a pair with *tâpalu* in Šurpu III 89 (Table 3.2 10).
šir	šìr (=EZEN)	S	'song', originally 'composition' (?). *Cf.* šìr.NAR/kad$_4$ Išme-Dagan VA 61 (Ludwig, M.L., *Untersungungen zu den Hymnen des Išme-Dagan von Isin*, (Wiesbaden, 1990), 193-5).
šir saĝ	šìr.saĝ	S	'first song'.
šud	šùd	S	'prayer' also in the combination gal$_a$.šùd '(leader of the) prayer singer(s)' ED Lu A 107.
šukara	$^{(ĝiš)}$šu.kara$_2$	C	'carried by the hand, utensil' is attested in the OB Hh I 619 and not in the later versions. That it is the Syrian lyre with a hornlike summit is indicated by the part siezen = *qarnânû, qarna-inû.*
tigi	$^{(ĝiš)}$tigi = NAR. BALAĜ = *tigû* (A); ti.gi (B); ti.gi$_4$ (C)	C	The sign combination means 'harp of the singer' (?).

tigidlu	$^{(ĝiš)}$ŠA$_3$.TAR = tigidla = *tigidallu* (?) (B)	C	The sign combination ŠA$_3$.TAR might be interpreted as 'split heart' indicating the fingerboard of a lute crossing the sound box. tigidla < *tigi.dal 'crosspiece of the *tigi*' could refer to the neck of a lute resembling the crosspiece of a lyre. Beside the general indication tigidla (OB Hh I 613; MB Hh 4264) there are special types: tigidla.kaskal.la 'travel *tigidlu*' = *ḫarḫadutu* GN (?) (OB Hh 614; MB Hh 4265); tigidlu.sa.3 '*tigidlu* with 3 strings' = *talmuttu* '(instrument of) Dilmun' (OB Hh I 615; MB Hh 4266-4267, see also balaĝ dilmun); tigidla.elam.ma '*tigidlu* from Elam'. ^{ĝiš}ŠA$_3$.TAR = tigidla occurs in Ur III-Early OB administrative texts from Isin. Since three strings are mentioned, the identification with a lute is most likely.
ub	AB$_2$xŠA$_3$ = ùb/ šèm (A); ub$_x$ = AB$_2$.ZAG.TAK$_4$ (B) = *uppu* (= ^{kuš}ùb)	P: M	'cylinder'. See notes to šim(da) above. urzababa
urgula	$^{(ĝiš)}$ur.gu.la	C	'bigger dog, lion', a kind of lute ? (see Šulgi B 166)
urzababa	$^{(ĝiš)}$ur.za.ba$_4$.ba = *urzababitum*	C	'The one (instrument) of Urzababa' in Hh VII B 80-84 is someone associated with the god Ninurta, the zamin/arre ('instrument of praise') of Inanna and the mythological bull *alimbû*. Possibly a sort of lyre.
zam / zamzam	za.am.(za.am) = *samsammu* (B)	P: M	onomatopoeic (?); a percussion instrument or a type of song often connected with gisug 'flute' (CA 36, Urnamma A 3, 187, Šulgi E 38, 56 etc.) or tigi 'big lyre' (Šulgi B 273, 276, Šulgi E 34, etc.). For the determinative sign uruda see ^{uruda}za.am.za.am Hh XI, recontruction // Hg 191. Reduplicated, onomatopoeic (?) form like dubdub (= balaĝdi), *halhallatu*, and lilis.
zamin	zà.(me) (A), $^{(ĝiš/}$ $^{kuš)}$zà.mí (B) = *sammû* (C)	C	'wide side' (Krispijn, '*Beiträge*', p. 6-7) also 'to be praised' *cf.* zà.me = *wâdium* 'praising' VE 1181. In MB Hh zamin is translated *mandû* 'pole', which would fit the crossbar of a lyre. Parts of the lyre mentioned from OB Hh onwards are: ^{ĝiš}kul.zà.mí 'handle of the zamin'= *hansû* 'fibres (of the (OB Hh I 611; MB Hh 4259'. ^{ĝiš}dub/KAB.zà.mí (OB Hh I 611; MB Hh 4259'; VII B 50) = *tuppu ša sammê* 'board (?) of the zamin'= *hansû* '?'; ^{ĝiš}áb.zà.mí (MB Hh 4260) 'cow of the zamin' = *hasis sammê* 'ear of the zamin = sound hole (in the shape of a concave square)' (see E. Robson, Mesopotamian Mathematics 200-1600 BC (Oxford, 1999), pp. 50-4). In Hh VIIB 45 (reconstructed) zamin is explained as ár.re 'The (instrument) of praise'. The Mesopotamian tuning system is based on the zamin: *cf* Hh VIIB 47. ^{ĝiš}zà.mí.si.sá = *išartu* 'the *isartu* tuning' = *harru* (Hg B II . ZÀ in that line (A) could be the abbreviation of zamin. It occurs in the combination gal$_a$.zà 'leader of the zamin-players' ED Lu A 108. ZÀ is apparently not the abbreviation of ZÀ.HA = enkud 'supervisor of hunting and fishing, fish collector' (Englund, Uruk, 142-319; Green, M.W., *JCS* 36 (1984), pp. 93-5). The enkud in its abbreviated form occurs in: gal$_a$.zà; nesaĝ$_{2a}$.zà; bara$_3$.zà; DILMUN$_a$. zà ED Lu A 82-85. ^{ĝiš}zà.mí occurs in Ur III-Early OB administrative texts from Isin. zamin forms a pair with *ṣibattu* in Šurpu III 91 (Table 3.2 10).
zannaru	$^{(ĝiš)}$za.na.ru = *zannaru, tindû, kinnaru*	C	Loanword from Hattic *zinar. In the Middle-Babylonian version it is beside *zannaru* translated with *tindû* '?' (also Diri III 45), *kinnaru* 'Syrian lyre'. In Hh B 86a // Hg B II 170 it is associated with ^{ĝiš}dim.nun = *tindû* 'magnificent pole' and in Hg B II 166 sur$_9$.ra 'plectrum'. For the relation of zannaru, ^{ĝiš}(za).inanna, and ^{d}inanna$^{za.za}$ see Krispijn, '*Beiträge*', p. 12.

Notes

1 See Krispijn, Th. J.H. (1991-1992) "The Early Mesopotamian Lexical Lists and the Dawn of Linguistics" *JEOL* 32: 12-22, especially 14-5.

2 For most identifications see Krispijn, Th. J.H. (1990) "Beiträge zur altorientalische Musikforschung 1: Šulgi und die Musik" *Akkadica* 70: 1-27, and Dumbrill, R.J. (2005-Victoria) *The Archaeomusicology of the Ancient Near East*, Lexicon: 387-454.

3 For these terms see *e.g.,* Kartomi, M. J. (1990-Chicago-London) *On Concepts and Classifications of Musical Instruments:* 318-21.

4 I use the term 'horizontal harp' for harps, whose sound box forms the horizontal base of the instrument and 'vertical harp' for bow-shaped harps and harps, whose sound box is placed vertically.

5 Cooper, J. and Heimpel, W. (1983) The Sumerian Sargon Legend, *JAOS* 103: 67-82 and Westenholz, J.G. (1997-Winona Lake) Legends of the Kings of Akkade: 51-53; see otherwise Michalowski, P. in this volume.

6 zamzam is often mentioned beside the tigi and the gisug indicating a type of song. *Cf.* Glossary.

7 Uruk IVa is an archaeological dating of a stratum in the Eanna complex in Uruk. The earliest fragments of lexical lists are found in these layers. The later Uruk III stratum (± 3000 B.C.) is contemporaneous with the site Jemdet Nasr. See for a general description of these earliest texts Englund, R. K., "Texts from the Late Uruk Period", in Attinger, P. and Wäfler M. (1998-Freiburg) Mesopotamien, *OBO* 160/1: 13-233; Sürenhagen, D. (1999-Heidelberg) Untersuchungen zur relativen Chronologie Babyloniens und angrenzender Gebiete von der ausgehenden Ubaidzeit bis zum Beginn der Frühdynastisch-II-Zeit, *HSAO* Band 8, has refined the stratigraphy of Uruk and especially the Eanna.

8 Since the sign GAL, which is the sign used for the Sumerian word gal 'big', occurs so often in the ED Lu A list, that I would suggest that it be considered as the precursor of lú 'man' of the later lists and not as an indication of the leader of a group of professionals.

9 See for the M.B. peripheral versions of Hh chapter 5.1.

10 Other comparable hymns are Šulgi C , E and Išme-Dagan V.

11 In 5A and 5B a beardless figure with typical headdress stands in front of the harps. Is he a singer?

12 Bibliography of the paleography of the 3rd millennium, Green, M.W. - Nissen H.J. (1987-Berlin) Zeichenliste der archaischen Keilschriftzeichen aus Uruk (*ZATU*) Archaische Texte aus Uruk (*ATU*) Band 2. Deimel, A. (1922-Leipzig) Die Inschriften von Fara I Liste der archaischen Keilschriftzeichen (*LAK*); Rosengarten, Y. (1960-Paris) *Répertoire commenté des signes présargoniques sumériens de Lagaš;* Schneider, N. (1935-Rome) *Die Keilschriftzeichen der Wirtschaftsurkunden von Ur III nebst ihren charakteristischen Schreibvarianten (Keilschriftpaläographie Heft 2).*

13 Bibliography of the 3rd millennium lexical lists, Civil, M. (1969-Rome) The Series lú = ša and Related Texts (*MSL XII*): 3-21: ED Lu A-E; Civil, M. (2008-Rome) The Early Dynastic Practical Vocabulary A (Archaic HAR-ra A) *ARES* IV: 99-102: EDPV A, EDPV B; Deimel, A. (1923-Leipzig) Die Inschriften von Fara II *Schultexte aus Fara* (SF). Sign Lists: Englund, R. K. – Nissen, H.J. (1923-Berlin) Die lexikalische Listen der archaischen Texte aus Uruk, Archaische Texte aus Uruk (*ATU*) Band 3, (1993), (Uruk IVa and Uruk III): ED Lu A; Pettinato, G. (1981-Naples) Testi lessicali monolingui della biblioteca L. 2769 (*MEE* 3): ED Lu A, E; G. NPL = *Lista di Nomi e Professioni* (Names and Profession List); Pettinato, G. V Testi lessicali bilingui della biblioteca L. 2769 (*MEE* 4): VE, EV.

14 Bibliography of the 3rd millennium literary texts: Biggs, R. D. (1974-Chicago) Inscriptions from Tell Abū Sālābīkh (*OIP* 99): IAS no. 116, 318; Edzard, D.O. 1997 *Gudea and His Dynasty,* RIM Early Periods Vol. 3/1. Toronto: Cyl. A, B.

15 Reconstructed: [ti.g]i₄ en-níĝ.e-si-sá.a.da 'with the en (?), the tigi-instrument that has organized everything'.

16 Bibliography of the iconography and abbreviations from the 3rd to the 1st millennium: A = Aruz, J. (ed.), (2003-New Haven-London) *Art of the First Cities*; B = Boehmer, R.M. (1965-Berlin) *Die Entwicklung der Glyptik während der Akkad-Zeit;* O = Opificius, R. (1961-Berlin) *Das altbabylonische Terrakottarelief;* R = Rashid, S.A. (1984-Leipzig) *Musikgeschichte in Bildern Band II, Lieferung 2: Mesopotamien;* S = Suter, Cl.E. (2000-Groningen) *Gudea's Temple Building The Representation of an Early Mesopotamian Ruler in Text and Image:* 170-76 (Börker-Klähn); plate A-C (Suter); Z = Ziegler, N. (ed.), (2006-Dijon) *La musique au Proche Orient ancien. Dossiers Archéologie et sciences des origines*, no. 310, février.

17 See also Aruz, *Art of the Cities*, no. 230, fig. 86. I interpret the small figure after the drummer as a young singer.

18 This small lyre is neither type A nor B. A special monograph, devoted to the lyres of this tomb, De Schauensee, M. (2002) *Two Lyres from Ur* corroborates the correctness of Woolley's reconstruction.

19 See for reconstructions Suter, Gudea: ST.10 (Gudea ?) = R 45; ST. 54 (Plate B) = R 51-52; ST. 15 (pl. B) = R: 70; Other fragments with parts of musical instruments and people clapping: ST.9 (Pl. A); ST.13 (Plate B); ST.25 (Pl. B); ST.53.

20 Bibliography of the lexical lists from the 2nd to the 1st millennium: Civil, M. (1969-Rome) The Series lú = ša and Related Texts (*MSL XII*): O.B. Proto-lu: 25-73), O.B. Lu.aslag2: 151-213); Civil, M. (2004-Rome) *MSL XV* The Series DIRI = *(w)atru;* Gantzert, M. (2008-Maastricht) *The Emar Lexical lists:* M.B. Hh (especially part 1: 101; part 2: 64); Landsberger, B. (1958-Rome) The Series Har-ra = *hubullu* Tablets V-VII (*MSL VI*): Can. Hh VVII (+ O.B./M.B. Forerunners); Landsberger, B. (1959-Rome) The Series Har-ra = *hubullu* Tablets VIII-XII (*MSL VII*): Can. Hh VIII-XII (+ O.B./M.B. Forerunners); Veldhuis, N. (1997-Groningen) *Elementary Education at Nippur The Lists of Trees and Wooden Objects:* O.B. Hh.

21 For this tablet of the O.B. Hh see Veldhuis, *Education*: 52. The transliteration of this O.B. forerunner is published in Landsberger, *MSL VII*: 181-241. Since Landsberger named the forerunners after the later canonical series HAR.ra=hubullu (Hh) and Veldhuis has not published a complete edition of all O.B. Hh texts I refer to this tablet of O.B. Hh in the following way: *MSL VII*: 181-196 = II A // Hh VIII-IX; *MSL VII*: 199-204 = II B // Hh X; *MSL VII:* 213-28 = II C // Hh XI; *MSL VII:* 231-41 = II D // Hh XII.

22 Bibliography of the 2nd millennium literary texts: Al-apin = *ETCSL* 5.5.4; Curse of Akkade = *ETCSL* 2.1.5; Enki's Journey to Nippur = *ETCSL* 1.1.4; Enkitalu and Enkihegal = *ETCSL* *5.4.02 (not yet published in ETCSL); Iddin-Dagan A = *ETCSL* 2.5.3.1; Inanna and Enki = *ETCSL* 1.3.1; Mariage of Martu = *ETCSL* 1.7.1; Lamentation over Nippur = *ETCSL* 2.2.4; Lamentation over Sumer and Ur = *ETCSL* 2.2.3; Lamentation over Ur = *ETCSL* 2.2.2; Lamentation over Uruk = *ETCSL* 2.2.5; Nanše-hymn A = *ETCSL* 4.14.1; Nisaba-hymn A = *ETCSL* 4.16.1; Summer and Winter = *ETCSL* 5.3.3; Šulgi A = *ETCSL* 2.4.2.01; Šulgi B = *ETCSL* 2.4.2.02; Šulgi C = *ETCSL* 2.4.2.03; Šulgi D = *ETCSL* 2.4.2.04; Šulgi E = *ETCSL* 2.4.2.05; TH = *ETCSL* 4.80.1; Urnamma A = *ETCSL* 2.4.1.1; Ziegler = Ziegler, N. (2007-Paris) Les Musiciens et la musique d'apres les archives de Mari (Mémoires de *N.A.B.U.* 10 = Florilegium marianum IX).

23 The other instruments mentioned in the Mari letter are chordophones: *algarsurum; kinnārum; mirītum; parahšitum; (pitnum); sammûm; tigitallum; urzababitum* and percussion instruments: *alûm; halhallatum; le'ûm; lilissum.* It is uncertain whether these were played in ensembles. See Ziegler, N. (2007-Paris) *Les Musiciens et la musique d'apres les archives de Mari. Mémoires de N.A.B.U. 10.* Orchestras are discussed on pp. 13-15.

24 Bibliography of second millennium literary texts:
• Examination A, Sjöberg, A.A. (1974) 'Der Examentext A', *ZA* 64: 137-176.
• *Balaĝ Utu …ekura* Cohen, M.E. (1974-Malibu) *Balag-compositions: Sumerian Lamentation Liturgies of the Second and First Millennium B.C.:* 418-442.

- *Balaĝ Uru amirabi*, Cohen, *Balag*: 536-603.
- Eršemma no. 159, Cohen, M.E. (1981-Cincinnati) *Sumerian Hymnology: The Eršemma:* 103-6.
- Eršahuĝĝa no. 1 22 Maul, S.M. (1988-Wiesbaden) *'Herzberuhigungsklagen' Die sumerisch-akkaischen Eršahunga-Gebete*: 73-81.
- KAR no. 119 Lambert, W.G. (1960-Oxford) *Babylonian Wisdom Literature*: 118-120.
- SAA no. 3 Livingstone, A. (1989-Helsinki) Court Poetry and Literary Miscellanea (SAA 3).
- Šurpu Reiner, E. (1958-Graz) Šurpu, a collection of Sumerian and Akkadian Incantations, *AfO*, Beiheft 11.
- BBSt King, L.W. (1912-London) *Babylonian Boundary Stones*
- LKA No. 70 Farber, W. (1977-Wiesbaden) *Beschwörungsrituale an Ištar und Dumuzi:* 129.

25 1 = reconstructed pronunciation; 2 = writings in cuneiform script; 3 = general classification: A = aerophone; C = chordophone; I= ideophone; M = membranophone; P = percussion instruments; S = singer; 4 = literal translation and notes.

26 dab_6 = tab means 'to stand together, beside each other'. Words beginning with the nominal prefixchain a.da- (a.da.min 'competition', a.da.lugal 'rival king', a.da.en 'rival king-priest') contain the comitative case element 'with, together'.

27 al can be both a substantive 'hoe' and verbal prefix for stative or passive forms.

28 It is uncertain whether ^{ĝiš}BALAĜ = *zu-mu-ba-ru$_{12}$* (*zumbaru*) VE 364 has a connection with this entry. *cf.* Civil, *Practical Vocabulary A*, p. 100), who relates it to Arabic *ṭanbūr* 'drum'.

29 *cf.*, šu.ga.lam Gudea Cyl. A VIII 6; XXII 21; XXXIII 25; XXVI 1.

30 *i.e.*, 'breeding' (ePSD). See also ĝišdua.

31 *cf.*, *asarru* 'an object to write on, cylinder (?)' CAD A/2, pp. 327-28.

32 Krispijn, T.J.H. (2002-Rahden) "Musik in Keilschrift Beiträge zur altorientalischen Musikforschung 2" in Hickmann, E. - Killmer, A.D. - Eichmann, R. (ed.), *Orient Archäologie Band 10, Studien zur Musikarchäologie III.*

Abbreviation:

Most abbreviations are listed in the *Chicago Assyrian Dictionary* (*CAD*), (Chicago, from 1956). Other abbreviations used: Can. Canonical; E.D.: Early Dynastic; EDPV.: Early Dynastic Practical Vocabulary; ePSD: Electronic Philadelphia Sumerian Dictionary (http://psd.museum.upenn.edu); ETCSL: Electronic Text Corpus of Sumerian Literature (http://etcsl.orinst.ox.ac.uk); EV: Abstracts from the Vocabularies of Ebla ('Estratti di vocabulari'); Hh HAR.ra = *hubullu:* Lexical Series, published in MSL V-X; M.B.: Middle-Babylonian; O.B.: Old-Babylonian; VE: Ebla Vocabulary ('Vocabulario di Ebla')

A NEW HYPOTHESIS FOR THE ELABORATION OF HEPTATONIC SCALES AND THEIR ORIGINS

Amine Beyhom

ولم يستعمل الذي بالكل مرتين مفعولاً إلى أكثر من أربعة عشر بعدًا، والذي بالكل مفعولاً إلى أكثر من سبعة أبعاد، والذي بالخمسة إلى أكثر من أربعة أبعاد تحيط بها خمس نغم، والذي بالأربعة إلى أكثر من ثلاثة أبعاد تحيط بها أربع نغم، والطنيني أكثر من بعدين. وإنما دعا إلى ذلك حسن اختيار لا ضرورة [...]

'...The double octave will not comprise, in practice, more than fourteen intervals; the octave, more than seven; the fifth, more than four intervals and five degrees; the fourth, more than three intervals and four notes; the tone, more than two intervals. It is experience and not the theoretical need which dictates it [...]'
Ibn Sīnā (Avicenna) – Kitāb-a-sh-Shifā' [11th century][1]

The reason for having eight notes in one octave is an arbitrary concept. There are diverging explanations but none is satisfactory. The first part of this paper offers another view based on the author's theory of Modal Systematics,[2] where basic principles are explained. The second part is a statistical analysis on the combination of intervals within the span of the just fourth, fifth and of the octave.[3] The conclusion proposes two hypotheses, the first on the elaboration of the heptatonic scale and the second on the origins of heptatonism.

Introduction

The reasons given as to why the modern scale is made up of eight notes are unconvincing. Some suggest numerical relationships and their properties and others acoustic resonance. There are also propositions stating the obvious: it is as it is because it cannot be different.

The first reason is based on the properties of numbers. It offers two alternatives, firstly the magical properties of numbers, and secondly the ratios between them. The first alternative is dismissed because it does not relate to musical perception.[4] Since Greek Antiquity, the second alternative has been the source of an ongoing dispute between the Pythagorean and the Aristoxenian schools.

The tetrad which was used by the Pythagoreans and their European followers provides the ratios of the predominant notes of the scale, as the Greeks perceived them (fig. 1: 176).[5] However, it does not give any clues, and no other theory does, as to why the cycle of fifths should end after its seventh recurrence.

Later developments led to scales with twelve intervals, as in the modern European model, and seventeen with the Arabian[6] and Persian paradigms.

There are no reasons either for the fourth[7] to be made up of three, or for the fifth to be made up of four intervals.

Then the Aristoxenian school raised a point of particular importance when it pointed out that the practice of performance and the perception of intervals are the keys to theory.[8]

The Pythagorean construction of intervals, which in part is based on superparticular intervals,[9] misled many theoreticians[10] into believing that acoustic resonance might explain the construction of the scale, on the basis of its similarities with it. However, this is inconsistent with the predominance of the fourth in Greek theory and, for example, in Arabian theory and practice today. Acoustic resonance shows that the fourth is not the consequence of a direct process.[11]

To put it simply, Pythagorean intervals are based on a relationship of numbers based on the tetrad, hence the following: 1:2:3:4. Therefore, any number can have a relationship with any other in the series. Figure 2, page 176, gives an example of an extension to 5 consecutive numbers: 1:2:3:4:5.

With time, new ratios appear. They come from combinations of the number 5 with the original four numbers in the tetrad. However, whenever acoustic resonance is assimilated with a generative theory, the only new ratios to appear are exclusively the consequence of number 5 in relation to the fundamental, (fig. 3: 177), and even if multiples equal to the powers of two of the frequency of the fundamental (upper octaves) can be equated with the fundamental, new ratios can appear but always excluding the fourth[12] (fig. 4: 177).

There are strong arguments in favour of the consonance with the just fourth.[13] However, acoustic resonance fails in that neither can it generate modal scales, nor can it give satisfactory answers as to the number of eight pitches in the octave, or three in a fourth.[14]

Part I. Differenciation, combination, selection and classification of intervals in scale systems: basic modal systematics

The study of interval combination within a fourth or a fifth would have entertained scholars since music and mathematics were found to suit each other. Aristoxenus had limited combination techniques for his understanding of *genera*,[15] but *Fārābī* saw them as systematic combinations.[16] The combination of intervals must obey rules. Thus heptatonism is made up of a small number of consecutive intervals which we shall call conceptual. They are placed in larger containing intervals, such as the fourth, the fifth or the octave. Aristoxenus used the quater-tone to define the size of conceptual intervals as well as for common denominator. With Cleonides it was the twelfth of the tone which was his common denominator[17]. *Fārābī* divided the octave in 144 equal parts[18]. This is twice the amount as in Cleonides. This shows how greatly *Fārābī* was influenced by the Harmonists, as Aristoxenus had them labelled. These scholars were focused on tonometry and generally used a small common denominator for a maximum of accuracy in their quantification[19] of intervals. However, the Aristoxenian school favoured the largest possible common denominator, *i.e.,* an interval which can also be used as a conceptual interval (a second among intervals building up to larger containing intervals such as the fourth, the fifth or the octave).

Let us take a *genus* with a semi-tone or a quarter-tone as largest common denominator, within a fourth. To find out how many semi-tones make up a fourth, add semi-tones, one after the other until the fourth is filled up (tab. 1: 174). These intervals make a form of alphabet the letters of which being multiples of semi-tones.

In table 1, page 174, the intervals labelled 1, 2, etc., are integers. They are multiples of the largest common denominator which is the semi-tone. If we place three intervals in a fourth, other intervals may not fit in any longer. For example, if we place two of the smallest semi-tone intervals, the largest interval to fill up the fourth is one-tone-and-a-half, that is three semi-tones. When a fourth is made up of three intervals, the alphabet is reduced and has only intervals equating to one, two or three semi-tones.

The *genera* made from the systematic combination of the intervals in the alphabet constitute the well known six *genera* of semi-tone scales (tab. 2: 174), among which the first[20] and the fourth[21], are mentioned by Aristoxenus. The first three *genera*[22] have two classes of intervals: the semi-tone class, 1, and the one-and-a-half-tones class, 3. This also applies to the three other diatonic *genera*, but in this case with intervals of one semi-tone, 1 and one-tone, 2. Interval classes can be expressed as capacity vectors, according to the number of intervals of each size they have (tab. 3: 174).

Another approach to the problem would devise a literal expression for the size of intervals expressed as multiples of the semi-tone, and then, arbitrarily, assigning the system amounting to the least integer number, as indicator of capacity. A good example is the *genera* with two one-semi-tone and one one-and-a-half-tones additional intervals (tab. 4: 174). The digits of the intervals are concatenated in a single integer. The lowest number in the series of three is 113. If we assign the smallest number in the series as a capacity vector, we need only count the number of occurrences of each interval. We start with the smallest one to find out what is the capacity of the corresponding scale systems. This is known as a hyper-system.

Taking, for example, vectors 2,0,1 and 1,2,0, with corresponding hyper-systems 113 and 122 as basis for generating remaining combinations. The intervals in each hyper-system can be combined differently in three sub-systems, or unique arrangements of intervals contained in the hyper-system. The reason for this is that each model contains a semi-tone which is repeated, in the first hyper-system and two one-tone intervals for the second. The outcome of the combination of intervals in a hyper-system containing three different intervals would be different. However, this configuration does not exist for semi-tone integer multiples.

Conceptual, quantification, and elementary intervals: Understanding theory and practice

In the Western equal temperament scale,[23] also known as the 12-ET system (equal-temperament with 12 intervals in the octave), both conceptual and quantification intervals may have the same value. The semi-tone is half of a tone. It is the smallest interval and therefore divides the fourth into five semi-tones. The fifth, is made of seven semi-tones: three-tones and one-half-tone. The octave has twelve semi-tones, that is six tones. The cent being equal to one hundredth of a semi-tone, appears to be more accurate. However, it has little purpose with the 12-ET since the semi-tone is the exact divider for all larger intervals.

With other systems[24], the smallest interval used, in theory, may neither be a divider of other intervals, nor a conceptual interval, or an interval which is used in the scales and melodies of a particular type of music. An example of it is the systematic scale defined in the first half of the 13th century by *Ṣafiy-y-a-d-Dīn al-Urmawī*, in his *Book of cycles*.[25] There, the smallest conceptual interval is the *limma*. The tone, is made up of two *limmata* and one *comma*, both Pythagorean.[26] The *limma* is equated[27] to the semi-tone. Therefore, a typical tone may take the form L + L + C, where 'L' stands for the *limma*, and 'C' for the *comma*. Therefore a pitch can be placed in a scale within the limits of these intervals.[28] In this case, the *limma*, and

the *comma* play the role of elementary intervals (they are used to make up other intervals in the scale). However, the *comma* is not a conceptual interval because it is never used as such between neighbouring pitches of a scale but only as part of another and larger conceptual interval. The *comma* and the *limma*, make up conceptual intervals used in the composition of other intervals such as the neutral second, called *mujannab* which, according to *Urmawī*, can be made up of two *limmata* (*i.e.,* L + L) or with one *limma* plus one *comma* (*i.e.,* L + C or C + L).

The difference between the two neutral seconds, *i.e.,* the difference between two *limmata* and one *limma* plus one *comma* (fig. 5: 177), or [(L+L) - (L+C) = (L-C)], is about 67 cents, almost three Pythagorean *commata*. Conceptually, however, the two possible forms of neutral seconds, with *Urmawī*, are equal. Both are called *mujannab* and considered as intermediate intervals placed between the *limma* and the tone.

Arabian theory has hardly changed since *Urmawī*.[29] Modern scholars give two principal representations of a scale with all possible locations of pitches.

The first is an approximation of the general scale with Holderian *comma*, HC, henceforth, and the second uses the quarter-tone for quantification.

A HC equates to $1/53^{rd}$ of an octave, about 23 cents $(22.6415)^{30}$. Therefore one *limma* equals to four HC, about 91 cents. This is close enough to the Pythagorean *limma*. The tone is 9 HC, or 204 cents, matching the Pythagorean tone. Typically, a tense diatonic *genus*[31] is modelled as a succession of two Pythagorean tones of 9 HC each, plus a *limma* with 4 HC tones. The *mujannab* of *Urmawī*, which amounts to a neutral second, has two possible values, 6 HC or 7 HC, but they are considered as identical conceptual intervals.[32]

The first division of the octave, the 53-ET giving the Holderian *comma* as a common divisor of all conceptual intervals, follows, in Arabian theory, complex rules that are given elsewhere.[33] The second division of the octave, in 24 theoretically equal quarter-tones, will demonstrate a privileged example of interval relationship.

At this point, it may be useful to explain how two intervals, which are different in size, can, according to *Urmawī*, be considered as identical conceptual intervals.[34] The best example is with the *maqām Bayāt*. It is based on the same scale as the *maqām Rāst*. The *Rāst* scale is composed of approximate three 'one-tone' and of four 'three-quarter-tones' intervals.

It could be noted as c d e- f g a b- c', with e- and b- being approximately one quarter-tone lower than their western equivalents. The scale of the *Bayāt* is close to the general structure of *maqām Rāst*, but begins with d and has a b flat (fig. 6: 178).

This gives d e- f g a b♭ c' d'.[35] The note e-, which has the same name in all theories of the *maqām*,[36] is placed

differently according to the context of the performance, or depending on the local repertoire (fig. 7: 179).[37]

In this *maqām*, the position of the degree *sīkā* has a lower pitch in Lebanese folk music than it has in Classical Arabian music in the Near-East. Should we decide to use a quarter-tone approximation for the intervals in Arabian music, as most modern theoreticians do, then the two neutral intervals between d and e- and between e- and f are conceptualised as two three-quarter-tones intervals fig. 6: 178). However, with the *Dal'ūna*, in *maqām Bayāt*, Near-Eastern folk music has a lower e-, which, regardless, is considered as a *sīkā*, but the lower interval between d and e-, the lower *mujannab*, is smaller than an exact three-quarter-tone (fig. 7: 179), and the higher interval between e- and f is larger.[38]

Furthermore, the positioning of the *sīkā* depends on which *maqām* is played as well as region and repertoire. A good example is in the difference between the position of the *sīkā* in the *maqām Bayāt* and the position of the same note in the *maqām Rāst* which in this case is higher in pitch, but lies approximately around the three-quarter-tone boundary. In the *maqām Sīkā*,[39] or one of its frequent variants, the *maqām Sīkā-Huzām*,[40] the position of *sīkā* is still higher and could sometimes reach the upper value of *Urmawī's* greater *mujannab*. This is the position assigned to this note in modern Turkish theory.[41]

The boundaries for these different positions for *sīkā* are not established in practice, and the study of its variations would require another paper.[42]

This pitch is perceived as a *sīkā* anywhere the player may perform. The difference is quantitative. However, the relative positioning of the note which is placed between e♭ and e, will always be perceived as a *sīkā*. Therefore, the conceptual understanding of the neutral second is not simply quantitative, but also relative and qualitative. Importantly, the *mujannab* is perceived as an intermediate interval between the one 'half-tone' and the 'one-tone' intervals. This applies for all other intervals such as the semi-tone which is an interval smaller than the *mujannab*, and to the 'one-tone' interval which is larger than the latter. The tonometric value of *mujannab* may vary,[43] but it is the relative position of the interval in the scale and its qualitative and relative size, compared to other conceptual intervals, which gives it its full value in the repertoire. To conclude on the nature of intervals in a scale, they are of three types:

1. An interval of measurement is an exact or approximate divider of other intervals. As a general rule, any musical system based on the equal division of the octave, as in an equal temperament, gives an interval of measurement, such as the semi-tone in the 12-ET, and with the quarter-tone in the 24-ET or the HC in the 53-ET divisions of the octave.

2. Conceptual interval. This is one of the consecutive

intervals of the second forming a musical system. For example, three seconds in a just fourth, four seconds in a just fifth, or seven seconds in an octave. Conceptual intervals can be measured either exactly or approximately with smaller intervals, usually of measurement, as in approximations using the quarter-tone or the HC.

3. Elementary intervals are used in combination to build up to consecutive conceptual intervals of seconds within a system. They can combine either with a similar elementary interval, such as with the two *limmata* in *Urmawī*'s general scale, which combine into a *mujannab* interval, or with another elementary interval, such as the *limma* + *comma*, for the second form of *mujannab*, with *Urmawī*.

These three types of intervals are not mutually exclusive. When the smallest conceptual interval is also the smallest common denominator of all conceptual intervals, as with the semi-tone in the 12-ET, then it becomes an interval of measurement, but it is also an elementary interval, although it remains conceptual when used as an interval of second within a musical system. The need to differentiate these three types of intervals arises within unequal temperaments, for example with *Urmawī*.[44]

This distinction will provide with a better understanding of the combination processes applied to music intervals.

Applying the concept of qualitative differenciation of intervals on *Urmawi's* scale

Urmawī's explanations about his scale show that the tone is composed of three elementary intervals and that no interval within the fourth may contain either three successive *limmata* or any two successive *commata* (fig. 8: 180).

The *comma* is neither a quantifying interval as it does not divide exactly other intervals such as the *mujannab* or the tone,[45] nor is it a conceptual interval, as it is never used as a melodic interval between two pitches in a modal scale.[46] Furthermore, a *comma* is never used as the first interval of a combination, with a notable exception for the *mujannab* which can hold the form 'C+L'.

A conceptual interval generally starts with itself or with another conceptual interval. The *limma*, for example, is used both as a conceptual interval, the smallest interval used in any of *Urmawī*'s modal scales and as an elementary interval used in the composition of other, relatively larger, conceptual intervals. With *Urmawī*, both the *comma* and the *limma*, are elementary intervals. However and additionally, the *limma* is also a conceptual interval.

In modal construction, and with an appropriate choice of pitches within the scale, with *Urmawī*, there are other conditions to be met. These include, for example, the inclusion of the fourth and of the fifth. They must be complementary in the octave. With such limitations,

we can conceptualise the intervals of adjacent seconds in *Urmawī*'s modes in the following way (fig. 8: 180):

1. A conceptual interval of one semi-tone is composed of a single interval, part of the scale. Since the smallest conceptual interval is the *limma*, we may conclude that the semi-tone is equivalent to a *limma*.

2. The *mujannab*, or neutral second conceptual interval is composed of two elementary intervals of the scale: the *mujannab* can be either composed of one *limma* + one *comma*, L+C, or of two consecutive *limmata*, L+L. It is the only interval with *Urmawī*, listed among intervals smaller than the fourth which may have two different sizes. As a corollary to this, two *mujannab* may follow each other, but only if they have a different composition such as when one is L+C and the other is L+L (or L+L then C+L).[47]

3. The tone is composed of three elementary intervals. However, a) three *limmata* must not follow each other.[48] b) The *comma* must always be preceded or followed by a *limma*. In this case, the tone can only include two *limmata* and one *comma*, with two possible arrangements: L+L+C, or L+C+L.

4. The greater, or augmented conceptual interval of the tone is composed of four elementary intervals. It can only be made up of three *limmata* and one *comma*. They can only be arranged in this manner: L+L+C+L or L+C+L+L. This interval is not mentioned in the *Book of Cycles*. It is only assumed as part of *Urmawī*'s seconds.

5. The greatest conceptual interval of the second is made up of 5 elementary intervals because the fourth can only be composed of a maximum of seven elementary intervals, within the systematic general scale. However, two other intervals of second (conceptual interval) are needed for its completion. Since the smallest second is the semi-tone, the *limma*, the greatest conceptual interval is equal to the remainder coming from the subtraction of two *limmata* from the fourth. The fourth is composed of two tones and one semi-tone, *i.e.*, 2x(2L+C)+L, or 5L+2C. Taking away two *limmata*, the resulting capacity of the greatest conceptual interval in a fourth is 3L+2C. Applying the rules of construction of the intervals, such as no more than two *limmata* in a row, etc., the possible forms of the greatest second, or tone, in *Urmawī*-type scales are L+L+C+L+C, or L+C+L+L+C. This interval is not mentioned as such in the *Book of Cycles* but is also assumed.

The fourth needs a combination of smaller intervals so that their sum can add up to its capacity in terms of elementary intervals. In order to simplify the process, we shall use a simple handling of numbers equating to the conceptual intervals of the second with *Urmawī*.[49]

1. The semi-tone equals number 1, as one elementary interval is needed to compose this conceptual interval.

2. *Mujannab* is given the value of 2 since two elementary intervals are needed to build it up to a conceptual interval.

3. The tone interval is given the value of 3 since it needs three elementary intervals.

4. The augmented tone has the value of 4 since it requires four elementary intervals.

5. The greatest interval of the second within a fourth has the value of 5 because it needs five elementary intervals.

Although having a quantitative function in terms of numbers of elementary intervals which make up a conceptual interval, numbers 1 to 5 express the intrinsic quality of the interval: its identification as a different conceptual interval from those represented with another number. As a common rule, the fourth is made up of three conceptual intervals. In order to comply with *Urmawī*, they must add up to seven elementary intervals.

Reduced to their hyper-systems, we have the following:

a. 115, with 1+1+5 = 7
(not in *Urmawī's Book of cycles*)
b. 124, with 1+2+4 = 7
(not in *Urmawī's Book of cycles*)
c. 133, with 1+3+3 = 7
d. 223, with 2+2+3 = 7

Therefore, in this case, a fourth may contain, either a) two semi-tones, 1, and one greatest interval of second, 5, or b) one semi-tone, one *mujannab*, or neutral tone, 2, and one augmented, or greater tone, 4, or c) one semi-tone and two intervals of one tone, 3, or d) two *mujannab*, or neutral tones and one one-tone interval. The algorithm for these hyper-systems is straight forward (fig. 9: 180).

To find the first hyper-system, (fig. 9: 180, first step) take the smallest conceptual interval, 1 twice in this case, and then deduce the value of the third interval by subtracting the quantitative value of the first two, which adds up to 2 elementary intervals, from the value of a fourth, or 7 elementary intervals, which gives 5.

The second hyper-system, the 124 hyper-system above, is obtained by decrementing the value of the last digit interval in the preceding first hyper-system, (fig. 9: 180, second step) and by incrementing accordingly the value of the interval standing just before in the series: the last digit in the first hypersystem is 5, which is decremented to 4, and the interval which precedes it, which is the central 1 in the 115 hyper-system, is incremented, accordingly, to 2.

The simultaneous decreasing of one interval value by one unit, or its decremention, with the increasing of one other interval value by the same unit of one, or accordingly incrementing it, insures that the sum of the numbers in the series remains unchanged. Here it is equal to 7.

Applying the same process to the resulting hyper-system 124, (fig. 9: 180, second step — repeated) the third hyper-system is now 133. Applying the same process to this last hyper-system would result in 142.

The capacity of this series is, however, the same as for 124. The reason is that in the preceding 133, the last two intervals were equal but with the continuation of the process in the same way, interval values for the central three are the same as the preceeding values for the last three, *i.e.,* 4 and 5, and reciprocally, which would result in the same composition of intervals, in terms of quantity, within the fourth. At this point, we need to improve the algorithm in order to find the remaining hyper-systems. This is done by decreasing the rank of the intervals to be modified by applying the same process to the interval the rank of which is immediately below the rank of the interval to which the decrementing process was last applied, *i.e.,* 133. The latter is the third interval in the series and now we must decrement the second interval in the series, and increment, accordingly, the preceding one, the first interval in the same series. Applying this process to 133 which we found in the preceding step, the second interval, central 3 (fig. 9: 180, 3rd step) is decremented to 2, and the first interval, 1, is also incremented to 2, whilst the third interval, which is the last 3, remains unchanged. This gives the new figure of 223. This is where the generation process ends since the two first intervals have now similar values. Any further step would generate a redundant hyper-system.[50]

Now that we have determined the hyper-systems agreeing with *Urmawī*, we need extract all possible *genera* and shades to give the full range of intervals in the fourth. The next section will review combination processes of intervals, for any hyper-system.

Various forms of interval combination

There are different methods for combining intervals. One is the rotation and permutation process. It is the most common. Rotation was used, notably, by Aristoxenus in his Elements of Harmonics,[51] and permutations were often used throughout history, and most probably by *Fārābī* in his *genera*, adding to Aristoxenus' range of tetrachords.[52] Both processes are deficient since they do not give, in their simplest expression, a full account of all the possible combinations. The tree process given below has the whole range of results. However this is more related to statistical and probabilistic analyses.

There are other procedures, such as de-ranking, which can be considered as a general case of the Byzantine-wheel method. Modal systematics uses them all for the purpose of arranging and classification, with special recourse of the de-ranking process.

Rotation of intervals

Rotation (fig. 10: 181) is a straight forward process by which intervals may be combined, placing the first after the last one, or inversely, the last before the first, leaving the other intervals in their position.

The first method is a clockwise process which continues as long as the first interval does not come back to its initial position, obviously. Figure 10, page 181, shows that this process generates intervals in three different ways (the first does not rotate since it places the interval system in its original and basic position). However, the rotation process is defective, as it always gives three possible combinations of three intervals, whenever the combination possibilities for these three intervals allows for six different combinations.[53] For the purpose of his explanation, Aristoxenus used intervals of the enharmonic *genus* which are made up of two quarter-tones and one di-tone, that is two equal intervals out of three. Figure 11, page 181, shows intervals with subscript numbers so that they retain their initial rank in the basic configuration, that is a1 as the first interval of the basic configuration, a2 as the second and b3, as the third. Even then, the rotation process gives three distinct combinations. If the three intervals are equal to *Fārābī's* equal-tone distribution where each is 5/6 of a tone, a combination process, whatever it may be, will always give the same result as combining the three intervals a a a.

Other processes are more effective but Aristoxenus' use of this limited process might have been a consequence that he considered interval combination as a de-ranking process.

Permutation of intervals

Permutation exchanges one interval for another whilst others remain fixed. The same process is applied to another pair until all intervals have changed places.

With direct permutation (fig. 12: 181), interval a1 of the basic configuration a1 a2 b3 is first changed with interval a2. This results in combination a2 a1 b3. Then, coming back to the original configuration, with b3, which is the combination of b3 a2 a1. As a1 has already changed places with the two other intervals, we procede with the second interval of the basic configuration, a2, with the others. This interval has already changed places, in the previous process, with a1: it should further change places with b3 only with the combination a1 b3 a2. The last interval has already changed places with both other intervals a1 and a2, and this is where the process ends.

If a1 is different from a2, and also from b3, then the second combination: a2 a1 b3 is different from the first combination, because it is a stand-alone interval system. The total number of distinct interval systems which result from the direct permutation process is 4, that is one more than with the rotational process. If both intervals are the same, however, if a1=a2, the two first combinations are equal. The process only gives three different combinations, similarly to those in the rotation process. In order to obtain the full range of possible combinations for these three intervals, we could apply the process of direct permutations, not only to the original configuration of a1 a2

b3, but also to each of the combinations which result from the direct combinations of a2 a1 b3, b3 a2 a1 and a1 b3 a2. If we apply this process to the second in the direct permutation process, combination b3 a2 a1, we obtain the following combinations:

1. New base: b3 a2 a1. This is the second combination in the direct permutation process. (fig. 12: 181)

2. Combination N°2: a2 b3 a1, consisting in exchanging the first interval with the second. This is a new combination, different from all the previous ones.

3. Combination N°3: a1 a2 b3, consisting in exchanging the first interval in the new basic configuration with the third one. This gives the same combination as the first one in the direct permutation process.

4. Combination N°4: b3, a1, a2, by exchanging the second interval in the new basic configuration with the third interval of the same. This is also a new combination.

Therefore we have two new interval combinations which added to the four distinct combinations of the direct permutation, amount to six different combinations of the three intervals a1, a2 and b3. These amount to the possible combinations with three distinct intervals. There is no need to apply the permutation process for the other combinations stemming from the first direct process. It is also possible to obtain a similar result with processes other than the successive permutations method, for example by applying rotation followed by a direct permutation process (fig. 13: 181). In this combination process, a direct permutation process is applied to each of the combinations coming from an initial rotation process (fig. 11: 181). This gives six independent and distinct combinations out of twelve. The six remaining combinations are redundant.

Let us be reminded of two characteristics of the reviewed combination processes:

1. The successive, or consecutive permutations and the alternate rotation/permutation processes generate a certain number of redundant combinations which have to be excluded from the outcome.

2. Out of six distinct resulting combinations obtained, three will be redundant if a1 equals a2. In this case, the outcome remains the same as for a simple rotation process (compare with fig. 11: 181).

Tree processing[54]

Here, in the tree processing the combinations are based on an initial choice of intervals, rank by rank (fig. 14: 183). With the first rank, we may chose between the three intervals a1, a2, or b3 (the subscript plays here more the role of identifier for each interval, than the role of an initial rank number).

Having completed this first step, we still have two intervals of which one must be assigned to the second position in the series. The third step leaves us with one possibility since two out of three intervals have already been used.

The process is straightforward as it gives directly the six distinct combinations seen above. There are no re-dundancies although intervals a1 and a2 could be taken as equal. In this case, again, we only have three distinct combinations.

The tree processing method is rarely used for com-bination of intervals and this is one of the reasons why we have to explore further the de-ranking process which is of crucial importance in modal systematics[55] as it is a practical way for arranging and classifying large numbers of interval combinations, such as in the heptatonic scales.

The de-ranking process, or picking intervals 'N' in a row out of repeated series of 'M' conjunct intervals - Hyper-systems, systems, and sub-systems.

De-ranking is closely related to rotation. It is very useful and in the study of musical systems applies mostly to the double octave. In a reduced form, the de-ranking process takes it that a series of conjunct intervals is re-peated a certain number of times, for example for in the series a1 a2 b3 a1 a2 b3 a1 a2 b3…[56] By de-ranking the first interval, we start the series of intervals by the first interval a2 instead of the first interval a1. We may consider this process as a rotation of intervals where the first a1 goes to the end of the extended series. If we choose N intervals out of a repeated pattern of N intervals, this process is a repeated rotation where N = M = 3. (fig. 15: 183)

In a more general application of this process, N in-tervals in a row are taken out of a series of M, repeated at least once, with both N and M being integer numbers. In the case of five intervals a b c d e repeated once in a row, for example (fig. 16: 184), we can pick up any series of three conjunct intervals to form a combination. The first ranking combination is a b c, the second b c d, the third c d e, etc.

If we apply this process to a double heptatonic tense diatonic scale, and in turn select seven conjunct intervals among the fourteen of the series (fig. 17: 184), beginning with the first interval, the second, the third, etc., and until the seventh, we obtain the seven different species of the scale.[57] In figure 17, page 184, the basic scale is 1 2 2 1 2 2 2, in which intervals are expressed as multiples of the semi-tone. This corresponds to the diatonic, and here also, the equal temperament western scale beginning with B or its equivalents (b, b', etc.), or B 1 (semi-tone) c 2 d 2 e 1 f 2 g 2 a 2 (b). Of all possible species of the double diatonic octave, this scale corresponds to the lowest value when ex-pressing the concatenated intervals as an integer number.

With modal systematics, the first in a series of de-ranked combinations is considered as the basic system.[58]

The others, in this example, are sub-systems of system 1 2 2 1 2 2 2 (fig. 18: 185). The hypersystem is the interval capacity indicator that we find in arranging all

intervals in a combination from the smallest to the largest. For example, in the hyper-system 1 1 2 2 2 2 2, from which we get that the capacity of all corresponding systems and sub-systems is equivalent to two one-semi-tone intervals and five one-tone intervals, there are other systems which are distinct from 1 2 2 1 2 2 2. They have the same ca-pacity, within the same hyper-system. In order to find all systems and sub-systems originating from a hypersystem, one needs apply, for example, a combined process of ro-tations/permutations to its intervals.[59] This has been ex-plained above[60]. If we eliminate the redundant systems or sub-systems, we find two other systems for hyper-system 1 1 2 2 2 2 2. The first of these two distinct systems is the hyper-system itself, as it expresses an arrangement of intervals 1 1 2 2 2 2 2 , which is different from 1 2 2 1 2 2 2, where the two semi-tones in the first combination are placed in a row. This system has in turn seven sub-systems. In this case, they are species. The remaining system which has the same interval capacity as the precedent ones but whose intervals are arranged following a different pattern where two semi-tones are separated alternately by one, then four, one-tone intervals, is 1 2 1 2 2 2 2, and has, ac-cordingly, seven distinct sub-systems. Figure 19, page 185, shows how hyper-system 1 1 2 2 2 2 2 has intervals that can be combined in three distinct systems which in turn, give seven different combinations or sub-systems obtained from de-ranking.

This hyper-system is peculiar in that it is the only one composed exclusively of one 'semi-tone' or one 'tone' intervals. If to our alphabet of intervals, we add the 'one-and-a-half-tones' interval class in our model, we find two other hyper-systems, 1 1 1 1 2 3 3 and 1 1 1 2 2 2 3. These generate 15 and 20 distinct systems, respectively, or 105 and 140 distinct sub-systems. They are too numerous to be listed here, but an example of sub-system from the first hyper-system is the scale of the well known Ḥijāz-Kār Arabian mode, with two Ḥijāz tetrachords (1 3 1),[61] separated by a one-tone interval: 1 3 1 [2] 1 3 1.[62] Another example, related to the second hyper-system, is the scale of the contemporary Arabian maqām Ḥijāz, which com-monly follows the scale 1 3 1 2 1 2 2 when reduced to a semi-tone scale without neutral intervals.

Now if we wanted to express the intervals of these hyper-systems in the equal-quarter-tones distribution of modern Arabian theory, then this would give:

- 2 2 4 4 4 4 4[63]
- 2 2 2 4 4 4 6
- 2 2 2 2 4 6 6

If arranged in agreement with modal systemat-ics classification, with the lesser values of hyper-systems holding the lower rank, their places would be reversed as:

1. 2 2 2 2 4 6 6
2. 2 2 2 4 4 4 6
3. 2 2 4 4 4 4 4

Let us now take in consideration the two neutral intervals used in modern Arabian theory. These are the three-quarter-tone '3' and the five-quarter-tone '5' intervals, which are conceptually differentiated from the one-semi-tone, one-tone, and one-tone-and-a-half. Combining the five intervals 2, 3, 4, 5, and 6 in seven possible positions, with the condition that the sum of the intervals must be equal to 24 quarter-tones, we end up having 19 hyper-systems (tab. 5: 175) with a possible number of 4795 sub-systems or scales. Among them, there are very few in usage. Scales used in semitone hyper-systems such as hyper-systems no. 1, 6 and 12 in the table, are limited to the diatonic and to the *Ḥijāz-Kār* or *Ḥijāz* type scales. For the remaining hyper-systems, scales used in the performance, practice and theory of Arabian, Persian and Turkish[64] music are remarkably few, no more than 150 to 200 when compared to the possible number of 4975, or out of more than eight thousand possible sub-systems with the extended alphabet (*i.e.,* with intervals greater than the one-and-a-half-tones), as we shall see in Part II.[65]

Some preliminary remarks on the systems and sub-systems of the quarter-tone generative model can already here be expressed:

a) Homogeneity of interval composition within a hyper-system results in a lesser number of systems because of the redundancy factor. The less the interval contains different classes of intervals, for example hyper-system no.12 contains only two classes of intervals, the 2 and the 4, the less it generates systems and, consequently, sub-systems.[66]

b) Two relatively homogeneous hyper-systems, no. 16 = 2334444 and 19 = 3333444, generate scales which are mostly used in Arabian music. Hyper-system no. 17, although very homogeneous, 3333336, is not in use because its intervals can add up neither to a fourth (sum=10) nor to a just fifth (sum=14).

c) Hyper-systems nos 1, 6 and 12, share with hypersystem no. 19 an important feature: more than half of their sub-systems have a fourth or a fifth beginning with the first interval.

d) System 2 4 4 2 4 4 4 in hyper-system no. 12 (this is the diatonic system that we have noted before) maximizes the number of fourths or fifths since six out of seven of its sub-systems contain a direct fourth and a direct fifth in relation to the tonic. Seven out of seven have either of them. This is the only system, among those generated with this model, with such qualities.

e) Hyper-systems which have the augmented seconds of Western music in a *Ḥijāz* tetrachordal combination (*i.e.,* containing at least one interval of one-and-a-half-tones – or 6 – and two intervals of one-semi-tone – or 2 – in the

form 2 6 2) generate large numbers of systems and sub-systems; these are hyper-systems no. 1, 6 and 9. This is an indication that these scales are a reservoir for modulation from and to diatonic scales.

f) Along with hyper-systems no. 12, 16 and 19, these generate about one hundred sub-systems that are the most frequently used or mentioned in specialized literature.

These scales, although stemming from hyper-systems with a reduced generative capacity, with about 22% of the total of sub-systems, form from two thirds to three quarters of the reservoir of scales used, or attested in Arabian music.[67] Their ratio of sub-systems with a double fourth and fifth from the tonic is close to 39% with most of the other sub-systems in usage (see rows with variants or 'close to' in the column of remarks of table 5, *i.e.,* hyper-systems nos 4, 10, 11 and 15 – the number of sub-systems marked FF for these represents a ratio of more than 46% of the total) contained in hyper-systems related to them.

g) In the 'Remarks' column with tab. 5, variants are mainly scales containing an alternative *Ḥijāz* tetrachord made up of intervals of 2, 3 an 5 quarter-tones. This is a possible indication that this tetrachord evolved from earlier forms such as 2 5 3 or 3 5 2, to our standardized form of 2 6 2, because of the pressure induced by the existence of the semi-tone equal temperament.[68]

These remarks, made on the basis of the quarter-tone generative model of modal systematics, suggest already some criteria which may be applied in statistical studies of systems and sub-systems as we shall apply in Part II of the present paper.

These criteria will help answer the question why out of 12 possible intervals in a semi-tone distribution, or out of almost 24 intervals in a quarter-tone distribution, only seven are combined, in most music, to form an octave? And why are there three intervals in a fourth and four in a fifth, generally.

Before answering these questions, we must return to *Urmawī's genera*, in order to have a better understanding of how, by applying the qualitative interval differentiation concept, uneven divisions of the octave can amount to even ones.

Applying modal systematics to *Urmawī's genera*

In *Urmawī's* model, we have distinguished intervals of the second by means of the capacity of integers, from 1 to 5 (fig. 8: 180). If we combine these intervals in the frame of a fourth, the sum of which must be equal to seven elementary intervals, we obtained the following hyper-systems:

- 1 1 5   • 1 3 3
- 1 2 4   • 2 2 3

Hyper-systems within the fourth as a containing interval, with two identical intervals generate one single system equivalent to the generative hypersystem. They amount to three: 1 1 5, 1 3 3 and 2 2 3. Among them, the last two agree with *Urmawī* in the *Book of cycles*, with intervals not greater than the tone. By de-ranking, possible combinations of the intervals contained in the three aforementioned hyper-systems are, for the first, combinations 1 1 5, 1 5 1 and 5 1 1. For the second, combinations 1 3 3, 3 3 1 and 3 1 3. For the third, combinations 2 2 3, 2 3 2 and 3 2 2. The remaining hyper-system, 1 2 4, generates two systems resulting in six distinct combinations which stem from 1 2 4: 1 2 4, 2 4 1 and 4 1 2, and stemming from system 1 4 2: 1 4 2, 4 2 1 and 2 1 4 (fig. 20: 186, left).

All *genera* in hyper-systems 2 2 3 and 1 3 3 are known both to *Urmawī's Book of cycles* and to modern *maqām* theory of the quarter-tone division of the octave. (fig. 20: 186, right).

The possible and missing *genera* in the treatises have in common peculiar features: each of them contains two small intervals in a row, either two consecutive conceptual semi-tones or *limmata*, or a *limma* and a *mujannab* in a row, similar to the 1 and 2 intervals in *Urmawī's* qualitative model (fig. 20: 186, left), and the 2 and 3 quarter-tones intervals in the quarter-tone model (fig. 20: 186, right). This is another criterion which will be applied in the statistical study which follows.

At this point, we may also note that the connection between the quarter-tone model and the model in *Urmawī's* qualitative interval equivalents is straight forward: in order to shift from *Urmawī's* model to the quarter-tone model, add one unit to each interval in the first. (tab. 6: 176) All the scales of the quarter-tone model connect directly with *Urmawī's* qualitative representation, through a unitary vector subtracted from the interval values in the former. For example, the *maqām Ḥijāz* scale, 2 6 2 [4] 2 4 4 (sum=24) in modern *maqām* theory (the square brackets identify the disjunctive tone between two tetrachords), becomes 1 5 1 [3] 1 3 3 (sum=17) in *Urmawī's* model, and the *maqām Rāst* 4 3 3 [4] 4 3 3, in quarter-tones becomes 3 2 2 [3] 3 2 2, or two similar tetrachords composed of, successively, one 'one-tone' and two *mujannab* intervals, with a disjunctive one-tone [3] interval.

In the model applied to *Urmawī's* intervals which consist in a division of the octave in 17 equal parts, the total sum of the intervals must amount to 17 elementary intervals in one octave. The transition to the quarter-tone interval is straightforward, as by subtracting one unit in each conceptual interval of a heptatonic scale in the quarter-tone model, we end up subtracting seven units from the total of 24 quarter-tones, which gives the sum of 17.

All the scales of the quarter-tone model, arising from the hyper-systems in table 5, page 175 have equivalent counterparts in *Urmawī's* model,[69] which proves that the two models are, in essence, conceptually equivalent.[70] As a further consequence, all the results from the statistical analysis, resulting from generations with the limited alphabet, from 2 to 6 quarter-tones, may be applied to Pythagorean equivalents in *Urmawī's* model.[71] Another conclusion may be drawn at this stage. *Urmawī's* concept of the scale, regardless of Pythagorean procedures used to explain, or legitimize his ideas about music, is profoundly Aristoxenian and based on a combination model. This applies as a rule to the composition of conceptual intervals using elementary intervals. The intervals within a fourth are derived from a combinatory process where the fourth and the fifth add up to an octave.[72]

Conclusion for part I

A quantitative model based on the equal division of the octave can be a qualitative model, taking in account the size of the intervals of which the scale is composed. They express the number of elementary intervals which build up each of the conceptual intervals. In the case of the quarter-tone model, the smallest elementary interval is the approximate quarter-tone (the measuring interval), the smallest conceptual interval is composed of two elementary intervals, or two approximate quarter-tones, etc. Combining the resulting conceptual intervals, we combine qualities of intervals that are differentiated by their capacity to contain elementary small intervals[73] (fig. 21: 186). This means that the scales which result from that type of generative model have intervals of seconds which, if measured exactly, would differ from one another even when having the same interval capacity (a one-tone interval in one scale may be slightly different from a one-tone interval in another scale).[74] However, these intervals, when taken in relation to other intervals in the scale carry a unique quality which differentiates them from the latter, which is typical of modal systematics.

Part II. Combining intervals in a system: statistical analysis

With modal systematics the basic process consists in combining intervals expressed as integers and then analysing the results in relation to both music practice and theory. The elements of the scale consist in a sequence of consecutive conceptual intervals.

Conceptual intervals are stand-alone units in the scale. They are distinct in theory and in practice. They are placed between the notes of the scale. Their function is qualitative.[75] For an immediate identification of any interval in a scale series, modal systematics determines the optimal (or the smallest, with the largest elementary interval) division of the scale, in such a way that the quantifying interval is the smallest conceptual interval and the elementary interval. In the semi-tone scale, the semi-tone is such that it fulfills the functions of quantifying, elementary and conceptual intervals.

With Arabian music[76], the semi-tone model is ineffective because conceptual intervals, such as the neutral tone or neutral augmented second - the *mujannab* and the greater tone in *Urmawī's* model in fig. 8, or the three-quarter-tones and the five-quarter-tones intervals in the quarter-tone model (fig. 21: 186), cannot be distinguished and identified as conceptual intervals. Therefore, another division of the octave is necessary to provide qualification for all types of intervals. In this case it is the 17-ET, or the division of the octave in 17 equal intervals[77] which is needed, since this division allows for the distinction of all conceptual intervals. These small intervals have values (fig. 8: 180) of 1 to 5.

Integers segregate the semi-tone 1, the *mujannab* or neutral second 2, the tone 3, the neutral augmented tone, or greater tone above 4 and the fully augmented tone, greatest tone above 5.[78] However, the 17-ET model has a flaw which makes it difficult to see it as a representative division of the octave. If taken strictly as a measuring interval, the 17th of an octave is 71 cents (fig. 22: 187). Adding these intervals, we have 494 cents for a fourth and 706 cents for a fifth. These figures are close enough to the corrected values of the fourth and the fifth in the Pythagorean system, *i.e.,* 498 cents and 702 cents. The problem lies with the representation of the semi-tone. If the 17th of an octave is conceptualised as a semi-tone interval, the discrepancy with an equal temperament semi-tone, in approximation is 29 cents, or 100-71=29, which is unacceptable to most musicologists. As a result, and although the measuring 17th of an octave interval which divides the octave in 17 equal parts is also an elementary[79] and a conceptual interval,[80] we shall take the quarter-tone model for Arabian-Persian-Turkish music bearing in mind the equivalence between the two models.[81]

The principle of economy: optimal balance between method and expression

In his first paragraph of his *Tonality of homophonic music*, Helmholtz said of the musician's liberty that:

> 'Music was forced first to select artistically, and then to shape for itself, the material on which it works. [...] Music alone finds an infinitely rich but totally shapeless plastic material in the tones of the human voice and artificial musical instruments, which must be shaped on purely artistic principles, unfettered by any reference to utility, as in architecture, or to the imitation of nature as in the fine arts, or to the existing symbolical meaning of sounds as in poetry. There is a greater and more absolute freedom in the use of the material for music than for any other of the arts. But certainly it is more difficult to make a proper use of absolute freedom, than to advance where external irremovable landmarks limit the width of the path which the artist has to traverse. Hence also the cultivation of the tonal material of music has […] proceeded much more slowly than the development of the other arts. It is now our business to investigate this cultivation.[82]

For thousands of years, freedom in music has been restricted by the necessity to produce recognisable pitch patterns making up melodies.[83] To this end, most cultures use heptatonic scales. They are a paradigm for composition. In order that a melody can be recognised, the degrees of the scale must be identifiable by pitches in relation to the other degrees of the scale. When these are expressed as intervals, they become conceptual intervals where each has its own quality so that they can be identified. Conceptual intervals must neither be too small as they would be too difficult to perceive, nor too big, as in both cases melodies may not be easily perceived.

Variations of intonation or subtle differences of intervals, especially with music which does not answer to any known temperament, are the consequence of impromptu performance, great mastery, regional variations, organology, particular tuning and so forth, all combined with the ability of the performer.[84] In a traditional process of knowledge transmission, however, these subtle variations, particularly in the domain of performance mastery and instant creativity, take place at a later stage of music understanding and perception. In order to transmit and receive, a basis must be found allowing for a firm structure of the musical discourse, whilst allowing the performer the possibility to further develop his freedom of interpretation. This basis, which is the essence of the melodic repertoire, is commonly named the scale.

When confronted with an audience, a traditional musician of average talent would try to perform with utmost expression and invention, keeping in mind the need for a melodic pattern that his listeners will recognise. This process should request the least possible energy whilst taking the least possible steps within the continuum of pitch, in the search for balance between technique (or complexity

of the means used) and expression (or the effect of the musical discourse on the audience). In order to achieve this goal, this musician would ideally need to have previously tested all possibilities, within an octave or other important containing intervals, and determine which would result in the maximum number of expressive possibilities.[85] The process for interval combination and the search for the optimal number of intervals within a 'fourth', a 'fifth' or an 'octave'[86], will be defined as stemming from the principle of economy.

A semi-tone and quarter-tone model for *genera* and scales

The two models in this study are the western and the Arabian. Whilst western music uses the semi-tone, the quarter-tone is the basis of conceptual divisions with the *maqām* where subtle refinements reveal modal complexity.[87] In both cases, the smallest conceptual interval is an approximate semi-tone. A recurrent objection to the use of the semi-tone interval as a smallest conceptual interval is that the Arabian quarter-tone is half its size. Some theoretical modern descriptions of *maqām Awj Āra*, for example, show indeed one quarter-tone intervals in the scale. This *maqām* is reminiscent of Turkish music as its scale is similar to the maqām *Ḥijāz-Kār,* but with *awj* (= b-)[88] as its starting note. This causes some cultural and technical problems with the organology of the *`ūd,* because of the usage of the theoretical equal quartertone in the 1920s and 1930s.[89] These problems are easily resolved with the difference between conceptual and measuring intervals we have explained.[90]

Another objection to Arabian performance is mainly with *maqām Sīkā.* It begins, as its name suggests, with *sīkā,* = e-. In the quarter-tone model, this scale equates to 3 4 4 3 3 4 3, beginning with e- and with a b- between the conjunct two-three-quarter-tones intervals. In the common Arabian tuning of the *`ūd,*[91] the open strings of lower pitch are often used as drones repeating the fundamental note of the *maqām.*[92] In order to reinforce the fundamental, some contemporary lutenists tune the lowest auxiliary string to E-. Many, however, prefer to keep the original tuning[93] and use a technique of fast alternation between e- and a note about a third of a tone lower,[94] and quickly coming back and insisting on e- so that the fundamental e- is reinforced. The small interval used between e- and the slightly lower pitch is only a variation and is used intonationally. Its main function is to underline the importance of e-, the next, the lower degree in the scale being d, which is three quarter-tones away from e-. This is why the performer must use a smaller interval of intonation leading to the fundamental.

Now that these two main problems have been addressed and that the limitation of small intervals is taken in both models as equal to the conceptual semi-tone, two possibilities have been considered regarding the largest interval in the scale. It must be firstly limited only by the size of the octave, and by the minimum of two intervals amounting to a scale element, or secondly by the largest conceptual interval in both models, *i.e.,* the one-and-a-half-tones interval.[95] As a result, each generative process uses alternatively two alphabets. In the semi-tone generation, the first alphabet is without limitations except for the semi-tone division. The largest interval in the alphabet is the largest possible allowed in a particular generation. The second alphabet is reduced to the three conceptual intervals of one semi-tone 1, one tone 2, and one and a half-tones, 3, or augmented second.

This also applies to the generation process for the quarter-tone, except that in this case, the interval increments are quarter-tones, with a limited alphabet of 2, 3, 4, 5 and 6 of them (fig. 21: 186). The generative process is simple. A computer programme detects all the combinations of a certain number of intervals given in an initial alphabet of conceptual intervals, and arranges the results as hyper-systems, systems and sub-systems. This process starts with the minimum possible number of intervals in the scale elements[96] and ends with the maximum possible number of elements in the containing interval. The minimum number of intervals in combination is two, and the maximum depends on the containing capacity of the intervals in the model. With both models this corresponds to the number of half-tones in a row which can be arranged in a containing interval, *i.e.,* five for a fourth, seven for a fifth and twelve for an octave.

Preliminary definitions and remarks

Specialised terms for scale systems will be used throughout this study, their definition follows:

1. A scale system is a sequence of numbers for different classes of conjunct (conceptual) intervals within the frame of a containing element. This is defined as an interval composed of conceptual intervals with the sum of the containing element equating to the number of elementary intervals building up to it set to a certain value. Containing intervals are equal to the fourth, with an ascending frequency ratio of 4/3, and the fifth, with a frequency ratio of 3/2, and the octave.

2. A hyper-system is a capacity indicator of conceptual intervals. It is a scale element in which these intervals and the numbers composing the sequence, are re-arranged to form the least integer when numbers are concatenated. Hyper-systems are arranged, in the frame of a generative process, from the smallest (when expressed in integer concatenated form) to the largest.

3. A system is a particular arrangement of intervals in a hyper-system. Systems are also scale elements. They are arranged from the lowest corresponding integer to the highest within the hyper-system. A hyper-system is identical to

the first ranking system it generates.

4. A sub-system is a particular arrangement of intervals inside a scale element which corresponds to a de-ranked system. The original system is the first sub-system, and each de-ranking produces the next ranking sub-system. The number of conceptual intervals, NI, henceforth, limits the number of sub-systems in a system, as some of the combinations resulting from the de-ranking process may be identical and therefore redundant. The number of non redundant sub-systems may be lesser than the corresponding NI. The first ranking sub-system in a system is identical to the head system.

5. NI is the number of conceptual intervals of conjunct seconds which constitute a scale element. In the statistical study below, NI is variable and extends from two conceptual intervals in a scale element, to the maximum possible number of smallest conceptual intervals in a row within the containing interval. In both models, the maximum number of conceptual intervals in a scale element is equal to the number of conjunct semi-tones - the smallest conceptual interval - required to build it up. The maximum number of conceptual intervals in a containing interval (NImax) of a fourth is equal to the number of semi-tones needed, *i.e.,* five consecutive semi-tones (NImax=5). A typical example of the relationship between hyper-systems, systems and sub-systems is shown in figure 19, page 185, and table 5 where the 19 hyper-systems of the quarter-tone model generation with the limited alphabet 2, 3, 4, 5, and 6, and with seven intervals (NI = 7) to the octave, are arranged in ascending integer values. A typical hyper-system generates diatonic scales, *i.e.,* hyper-system no. 12 in the generation with the reduced alphabet (tab. 5: 175). This hyper-system generates three systems (fig. 19: 185) for the corresponding semi-tone model, when each in turn generates 7 distinct sub-systems by de-ranking intervals in each system.[97] Table 5 is specific to the general combination process used in modal systematics. Since the containing interval is equivalent to the octave, the sum of the integers (in unconcatenated form) in each scale is 12 half-tones in the semi-tone, and 24 in the quarter-tone model.

With the fourth, the respective sums in the two models are 5 semi-tones or 10 quarter-tones, and in a just fifth 7 and 14 respectively. The equality of the intervals of the semi-tone and the quarter-tone models is straightforward. For the transition from a semi-tone interval system to its equivalent in the quarter-tone model, simply multiply the intervals of the integers by two. To reverse the process, divide all the integers in the quarter-tone model by two. However, intervals represented by odd integers in the quarter-tone model have no equivalents in the semi-tone model. This is the reason why the ranks of the hyper-systems in the semi-tone model are corrected to their rank in the quarter-tone model, as explained in the next section.

The main question is why the generally assessed number of conceptual intervals in a modal scale is seven in an octave, or what is the optimal number of conceptual intervals in containing intervals with ratios 4/3, the fourth, 3/2, the fifth, and 2, the octave.

Combining intervals within a fourth: filters and criteria

In a combination process of conceptual intervals using the semi-tone as the smallest conceptual interval, the sum of the containing interval of the fourth[98] must be 5 in the semi-tone, and 10 in the quarter-tone models. Our first goal is to find all combinations of intervals of the alphabet that sum up to these values.

In the semi-tone generation (fig. 23: 188, top), the alphabet is unlimited, except by the semi-tone structure of the intervals. The smallest interval is the semitone, and the largest, for NI=2 (two intervals in combination) can therefore only be a 4 semi-tones interval, 4 in the concatenated sequence of intervals, '[14]' in the first hyper-system of the semi-tone scale generation with NI=2.

The sum of the two intervals in the first hypersystem is equal to 1+4=5. The other hyper-system for NI=2 is 23, with two intervals 2 and 3 (the semi-tone value is represented by the two digits.)[99] The rank of the hyper-systems (first column to the left) is given both in the semi-tone (plain numbers) and the quartertone models (between brackets) if the two differ. If the hyper-system does not exist in the semi-tone model, only the rank of the corresponding quarter-tone hypersystem is given (one number between brackets). For NI=2, the two hyper-systems 14 and 23 both generate one single system, with two sub-systems for each system. For NI=3, we still have two (but different) hyper-systems (or capacity indicators) which generate each one single system, but with three sub-systems each (due to the three conjunct intervals in the system).

This generation corresponds to the commonly accepted number of three intervals in a fourth, and contains the tetrachord equivalent of the tense diatonic genus, hyper-system 122, and of the tone, or tense chromatic: 113. For each of NI=4 and NI=5, we obtain one single hyper-system, with four sub-systems for NI=4, and five identical, (with four which are are redundant) sub-systems for NI=5. The total numbers of hyper-systems, systems and sub-systems in each case figure in the row below the last sub-system.

A first, and evident remark can be made. A small number of intervals, NI, implies that larger intervals have more chances to find a place in the system, whenever a larger NI results in an increased use of smaller intervals, notably here the semi-tone. Additional rows below the grand total give the numbers of remaining sub-systems for each NI whenever some eliminating conditions are met (the number of excluded sub-systems is shown in brackets, with a minus sign):

1. The total number of non-redundant sub-systems is equal to the initial total number of sub-systems minus the number of redundant sub-systems in each case. Redundancy occurs once in the semi-tone model, for NI=5. Here the hyper-system, system and sub-system(s) are identical, as one single interval class, the semi-tone, is used in the scale element. These redundant sub-systems, generated through the de-ranking process, are struck out in figure 23, page 188, and must be excluded from the generative process.

2. The 'double semi-tone criterion' (an asterix is added at the end of each sub-system which responds to this criterion) excludes (separately from other filters) sub-systems containing two semi-tones in a row (conjunct semitones).[100] This filter, which has been inspired from Arabian music, is most effective when applied to sub-systems with a large number of intervals of greater values. If two consecutive semi-tones are present in a heptatonic scale, they are commonly found at the sides of the junction between two tetrachords, or at the junction between a scale and its equivalent to the octave, lower or higher.[101] For larger containing intervals such as the fifth and the octave, this criterion is applied for three conjunct semi-tones.[102]

3. The 'conjunct large intervals' filter (sub-systems marked with §) excludes scale elements containing at least two conjunct intervals larger than, or equal to, the one-tone interval, and among which one, at least, is larger than a tone. This is a general rule which is present in the heptatonic Arabian traditional scales. Examples of sub-systems with such characteristics are 46 and 55[103] for NI=2 in the quarter-tone model (fig. 23: 188, bottom). The criterion is most effective with smaller values of NI.[104]

4. All these filters operate independently. If we combine them in one complex criterion, filtered subsystems will add up or merge ('neither nor', or a Boolean inversed 'OR' operator in the theory of ensembles) with a resulting number of filtered sub-systems in the row entitled 'Intersecting criteria 1'.

The aim is to compare, excluding all filtered sub-systems, the results of the generative process for different values of NI and to determine the optimal number[105] of conceptual intervals in the containing interval. The results of the semi-tone generation, with or without filters applied to them, are shown in the two graphics of figure 24, page 189. The generation with NI=3 (or three conceptual intervals in a containing fourth interval) gives the largest number of independent, non-redundant, sub-systems, i.e., 6. The filters or criteria, accentuate this optimal value. If we exclude scale elements comprising large intervals (greater than the one-tone-and-a-half)[106] in addition to those excluded through the 'intersecting criteria 1' composed filter, the remaining two sub-systems in the case NI=2 would be equally eliminated, leaving thus the case NI=3 as the unique possibility concerning the ability to generate a just fourth (see 'intersecting criteria 2', fig. 23:188).[107] The same applies to the quarter-tone distribution, (fig. 25: 190) with however some

quantitative and qualitative differences in the contents of the two generations.

A first difference is that the quarter-tone model (fig. 23: 188, lower half and fig. 25: 190) generates, as expected, intermediate and additional hyper-systems containing neutral interval equivalents (or odd multiples of the quarter-tone) which are for example hyper-systems nos 2 and 4 in the case of NI=2. Whenever the smallest and largest intervals are the same, in both semi-tone and quarter-tone generations, for the same NI (due to the limitation of the smallest conceptual interval to the semi-tone in both cases), then the intermediate hyper-systems generate additional sub-systems in the quarter-tone model. The optimal number of intervals (the most economic choice) is still three. All the filters accentuate the optimal value by giving the two neighbouring sections of the line a smaller angle (in fig. 25: 190, top, 'intersecting criteria 1' give the most acute angle around value 13 for NI=3). Figure 23, page 188 shows, however, that the new possibilities in the quarter-tone model are not fully integrated, for NI=3, in Arabian music, although this case comprises no redundant sub-systems.[108] The new sub-systems 235, 532, 523 and 325 are seldom or never used in this music, as the only configuration for hypersystem 235, with its two systems 235 and 253, seems to be the one which places the largest interval in the middle (i.e., sub-systems 253 and 352). If we were to add this criterion (i.e., if we dismiss sub-systems containing suites of very small intervals such as 23 or 32, in the quarte-tone model) to the filters already used for the semi-tone model of the fourth, we would end up having NI=3 as the unique possibility for this containing interval, because the remaining sub-systems for NI=4 are excluded by this criterion (see the row 'intersecting criteria 2' for the quarter-tone model in figure 23, page 188).

The reverse pycnon rule

All the filters and criteria used with the fourth correspond to common practice and theory and their application provides with complementary information on the aesthetics of modal music, especially with the *maqām* and modal diatonic music. It would be interesting however to try to find one single criterion which would have the same effect as the four criteria explained above.[109] Taking a closer look at the composition of the sub-systems commonly in use in the diatonic and Arabian music (fig. 23: 188: quarter-tone model, in bold), and comparing the sums for any two conjunct intervals within them, we come up with a very interesting conclusion. All these sums are comprised between 6 and 8 quarter-tones. Fig. 26: 191 shows pairs of conjunct intervals in ascending values from the top and the left, beginning with a first interval of 2, and conjunct intervals (from top to bottom), beginning also with a 2, incremented until the maximum which is 8 quarter-tones, in order to complete the sum for the fourth.

The next column shows the same process, starting with interval 3 and a conjunct interval 2, with the conjunct interval incremented by one unit downwards. The largest interval for this column is 7, since the sum of the two intervals may not exceed 10, which is the value of the fourth in multiples of the quarter-tone.

The process continues for the other columns until all possibilities are given. Common bi-interval combinations are written in bold on grey background for combinations commonly used in Arabian music, or on black background for diatonic *genera*. Sums are given on the top right or bottom left corners of each bi-interval element. Equality of the sums follows oblique parallel lines, from bottom left to top right (or reciprocally).

All series with two conjunct intervals found in the commonly used tetrachords are concentrated in the three oblique rows with sums of 6, 7 or 8. Other combinations have sum values below or above. This is a very strong indicator for homogeneous interval distribution of the intervals within the scale. If we add to all these bi-interval combinations other intervals, to the left or to the right and check those which follow the rules of homogeneity (fig. 27: 191), we end up having only common tetrachords listed in figure 23, page 188. With a single criterion applied to the intervals of the sub-systems within the fourth, there is a model which is the closest possible to common practice and theory. Furthermore, this rule of homogeneity is the reciprocal of Aristoxenus' pycnon rule which says that a pycnon (a bi-interval scale element composed of two small intervals within a fourth) must be smaller or equal to the one tone interval.[110] The rule of homogeneity observed with common *genera*, which we could also qualify as reverse pycnon, says the contrary (fig. 28: 192). The complement (here of any bi-interval combination inside the fourth) must have the same limitations as those for Aristoxenus' *pycnon*, and the bi-interval combination, although equal to, or greater than the one-tone interval (not a pycnon in Aristoxenus), has the same limitation as for the complement of the pycnon with Aristoxenus.

This important difference may have one of three causes.

1) With our modern music as with traditional forms, such as with the *maqām*, there has been important evolution diverging from their initial form, which initially, might have been close to Aristoxenus' descriptions.

2) Arabian music and Ancient Greek music were never connected, and the former evolved independently from the latter, or

3) Aristoxenus' description of the music of his time was not accurate or had no relation with practice.[111]

Applying the reverse pycnon rule to the fifth and the octave The last filter has shown the most commonly used *genera*. Consequently, it would be interesting to apply this principle to the fifth, or to the octave. This is simple enough,

with the fifth, and consists in adding an interval at one end and at the other of the *genus*, within the rules of homogeneity (fig. 29: 192), and then verifying the sums of the resulting combinations.[112]

As expected, this shows that most of the pentachords resulting form this operation have their equivalence in both literature and practice, although some of possible pentachords do not appear in the series.[113] Figure 30, page 193, shows an example of scale building beginning with the *Ḥijāz* tetrachord.

This is very similar to the generation of fifths, although less than half of the combinations (with a black background on the figure) exist in the literature or in the practice, with the remaining scale elements not found in the literature.[114] Possibilities for some limited hexatonic elements (for example 626262 and 262626 in the figure) also exist. As a consequence, whenever the rule of homogeneity applies to commonly used genera, its extension to the fifth and octave intervals is either inadequate or too restrictive, although it shows that the full potential of Arabian music, even with such a restrictive criterion, is still not fulfilled.

There is a noticeable exception with the *maqām mukhālif* which in Arabic means 'infringer', which has a limited scale of b- 3 c' 2 d^b' 4 e^b' 2 f^b where the two first intervals breach the rule of homogeneity. There are other *maqām* where conjunct tetrachords may form neighbouring semi-tones as for example in the *maqām Nawā-Athar* where the interval/tetrachord distribution is [4] {26*2*} {26*2*} (or a disjunctive one tone interval followed by two *Ḥijāz* tetrachords, where the two neighbouring semi-tones (in italics) also breach this rule (when applied to the octave). This is the main reason why, although the homogeneity rule is a perfect match-maker for tetrachords, we shall keep, for the following statistical studies in the frame of a fifth or an octave, the initial criteria given in figure 23, page 188.[115]

A little incursion in the eighth-of-a-tone model

The reader may be wondering why this study does not give more refined models, such as the eighth of a tone, for example. A first answer was given above and said that the purpose of interval generation was to use the least possible divisions in a containing interval with the utmost number of combinations, according to the principle of economy.

A second answer comes from the definition of the conceptual interval. Any interval in use in a scale should be relatively easily identified, both by performers and listeners alike (this procedure becomes difficult whenever the elementary intervals are smaller than the one-quarter-tone). However, and as a confirmation of the principle of relative size of intervals within a containing interval, we shall have a quick look at this possibility, in fourth.

When dealing with a new interval model, it must be first determined which are conceptual, elementary, or measurement intervals. When the measurement interval is one-eighth-of-tone, what would be the smallest conceptual interval? Two-eighths-of-a-tone would be too small because it equals a quarter-tone which is too small for being conceptual. A three-eighths-of-a-tone interval, as used by Aristoxenus in his hemiolic chromatic *genus*,[116] with two conjunct intervals of three-eighths of a tone and one interval of fourteen-eighths – or seven-quarters-of-a tone, would restrict us to the 17-ET inspired by *Urmawī's* theory (fig. 31: 194, central one tone interval), with a three-eighths interval equivalent to a *limma*, an elementary quarter-tone used as an auxiliary interval, and with two possibilities for the *mujannab* interval (see the three one-tone intervals to the right of figure 31, page 194).

On the other hand, four-eighths-of-a-tone is equivalent to one-half-tone, and choosing such a small conceptual interval, we would loose the benefit of having a smaller division of the tone.

As long as we do not want to differentiate conceptual intervals using too small elementary intervals, dividing the tone further than the quarter-tone (with the smallest conceptual interval set to the semi-tone value) would be pointless for the model, but could bring a better approximation of intervals used in practice. Figure 32, page 194 shows the graphic results of a generation in eighths-of-a-tone with the smallest conceptual interval being a semi-tone (4/8 of a tone), and elementary intervals being one-eighth-of-a-tone. This leaves space between the semi-tone and the tone for three intermediate intervals of five, six and seven-eighths-of-a-tone.[117]

The optimal number of intervals remains three (NI=3) with changes to the general curve of the graph. With four intervals and a very small increment such as one-eighth-of-a-tone, we have more possibilities than we had with the quarter-tone generation (for example for the case NI=4), but NI=3 remains the optimal value. If we add the principle of memory to the principle of economy, or the need for performers of traditional music to memorise the elementary scale divisions of the fourth (or archetypal *genera*) in order to reproduce them effortlessly while performing, we end up concluding that the eighth-of-a-tone model simply gives too many possibilities, which would also be difficult to distinguish from one another. One would associate the difficulty of perceiving intermediate intervals for the audience and the performer (the eighth-of-a-tone is 25 cents in size, very close to the Pythagorean comma which is approximately 23 cents), with a major difficulty (a huge number of *genera* to memorise) which introduces a *quasi* impossibility for the existence of a traditional repertoire based, as already stated, on the memorisation and identification of melodic patterns. To conclude, let us note that within a fourth, the case NI=3 (intervals) is the only one (still) that does not generate re-

dundant sub-systems, a characteristic we have already underlined for the other two models (with semi-tones and quarter-tones). This discussion is continued at the end of next section.

Combining intervals within the fifth

Modelling the fifth in semi-tones or with quarter-tones (with the restriction to the semi-tone as the smallest conceptual interval) gives additional information on the internal structure of containing intervals (fig. 33: 195).[118]

NI = 4, in both models, is the optimal value although noticeable differences exist between the two. The optimal value for the semi-tone model is clearly shaped, and accentuated with the application of filters to the sub-systems.[119] With the quarter-tone model, this optimal value has NI=5 as a competitor, and the filters give the latter a more important role, although less than for NI=4. Another difference is that the semi-tone model generates no redundancies (except for NI=5 which is a trivial case with 5 semi-tones in a row) whenever redundant sub-systems may be found in the quarter-tone model, including for N=4.[120] As a consequence, the semi-tone model is, within the fifth, more appropriate than the quarter-tone model.

For example, when reducing the results to the limited alphabet of 1, 2, 3 for the semi-tone model, the results (fig. 34: 196, compare with fig. 33: 195 above) show that the most effective filter is the disjunct large interval criterion which eliminates sub-systems containing intervals equal to, or greater than 3 semi-tones.

Discussing the preliminary results

Interval distribution within the fourth or the fifth provides with a preliminary answer to our greater question concerning heptatonism. Combination processes applied to conceptual intervals show that three intervals in a fourth and four intervals in a fifth correspond to an optimal value (a maximum of different *genera* for the least possible number of conceptual intervals) which reflects a balance between complexity (smaller interval identifiers such as the eighth of the tone or others, more intervals in a containing interval) and productivity in terms of independent (and fit for their role in music performance) interval combinations. This applies with or without the filters in resulting sub-systems. These filters reduce possibilities and give a hold on the internal mechanisms of modal music. Interval combinations chosen throughout history can be described and recognised – their positioning and qualitative sizes within the fourth or the fifth is not a coincidence. Furthermore, as we try to reduce the steps between intermediary intervals (as in the eighth-of--a-tone model of the fourth), the tendency towards a balance of the generations around the (same) optimal value remains, with however

quantitative differences between models. The semi-tone model seems to be best suited to the fifth, rather than to the fourth: the optimal value in the semi-tonal modelling of the fifth is very stable and the angle formed by the two bordering segments of the line is acute and (fig. 33: 195) accented in the case of a limited alphabet (fig. 34: 196); this optimal value still exists for the fourth, in the semi-tone model, but with a very limited number of combinations: in this case, only four major (diatonic) combinations may be used by the performer, which is somewhat limited compared to the twelve combinations in the quarter-tone model of the fourth (fig. 23: 188: nine *genera* are left if we filter the sub-systems with the second set of intersecting criteria). Twelve (or nine) combinations within a fourth seems a suitable reservoir for modal possibilities, alone or in combination, in performance or as paradigms for a repertoire as it gives the performer good possibilities for modulations, with the fourth as a starting containing interval that he can elaborate further and further (by modifying its internal structure – or interval composition), and then perhaps expand the span of the melody to the fifth or more. An eighth-of-the-tone model gives too many intermediate possibilities while adding perception difficulties (for example, an eighth-of-a-tone is much more difficult to recognize than a interval of one-quarter-tone, and the difference between a three-quarter-tone interval and a one-tone interval is much easier to distinguish from the difference between a six-eighths-of-a-tone interval and a seven-eighths-of-a-tone interval). With the fifth, however, the quarter-tone model becomes too rich,[121] and too complicated. Almost seventy possible combinations are available to the performer, which would be difficult to memorise.[122] It is easier to add a one-tone interval below or above the bordering intervals of the fourth. (fig. 29: 191). This is a process that would give some fifteen interval patterns available within the fifth. This is a practical means for enriching the repertoire with the least possible number of conceptual intervals. Even then, the semi-tone possibilities of the fifth compete with the potential of this last model. This is mainly due to the fact that the addition of one tone to the fourth reinforces the diatonic nature of interval combinations, as well as the possibilities for bi-fourth configurations (two intersecting fourths with successive ranks – fig. 35: 196).

Should we start our scale element with a one-tone interval (fig. 35: 196, left, the one-tone interval equates to the 4 quarter-tones), possible combinations complying with both rules of sum (for the adjacent fourth – in order to obtain a fifth) and the rule of homogeneity are more or less balanced between elements with neutral intervals (five) and elements with (exclusively) diatonic intervals (four). If we begin our element (ascending from left to right) with a neutral interval such as the three-quarter-tone interval

(fig. 35: 196, right), the remaining three intervals cannot make a fourth (their sum is always equal to 11 quarter-tones). In order to make a fifth, we are in some cases, for example 3345, 3434 and 3524, compelled to complete first the just fourth, then to add to it the one-tone interval, at the end. This process leaves us with only three possible combinations having both fourth and fifth, which is very little when compared to the nine possible combinations in the preceeding case in which we have set the first interval to 4, and in which all combination have both fourth and fifth.

In an open process, however, not taking into account the fifth as a necessary step on the way to the octave, the reduced potential of the starting neutral three-quarter-tone interval widens up very quickly (before being restricted once again by the octave).

As a preliminary conclusion, we may say that the quarter-tone model is particularly suited to the just fourth, whilst the semi-tone model is better suited to the fifth as a containing interval. Both models, however, show that the number of four or three intervals within a fifth or a fourth, is not coincidental, but it is the result of an optimisation process between complexity and expressivity.

A further remark can be made concerning octave systems of scales. What is applicable to the fourth also applies to a combination of two fourths with a one tone interval, or to combinations of fourths and fifths within the octave. Adding up the numbers of optimised interval repartitions for two fourths (twice three optimal conceptual intervals) + a one-tone interval, the optimal number of intervals for the octave is seven – the same applies to the total optimised number of intervals from the combinations of fourths (three optimal intervals) and fifths (four optimal intervals).[123] However, not all scales do follow the fourth-plus-fifth, or the two-fourths plus a one-tone arrangement of interval combination. In the following section we shall repeat the process used for the fourth, and apply it to octave scale elements.

Generating scales in the semi-tone and quarter-tone approximation models: preliminary exposé

With modal systematics, octave scales are represented as suites of conjunct intervals the sums of which are equal to the number of elementary intervals within the octave. This means that they must be equal to 12 semi-tones in the semi-tone model, or to 24 quarter-tones in the quarter-tone model.

In both models, the smallest conceptual interval is the semi-tone. In this study, as for the statistical studies of the fourth and the fifth, we extend the definition of the conceptual intervals beyond the restricted alphabet[124] (2, 3, 4, 5 and 6 quarter-tones in the quarter-tone model). Thus,

the smallest number of conceptual intervals to an octave – or NI – is one, and the largest NI is equal to 12 (fig. 36: 197, for an example of results in the semi-tone model), or 12 semi-tones in a row (or the smallest conceptual interval twelve times in a row).[125]

Intermediate cases (*i.e.,* NI = 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11 conceptual intervals to the octave) have an intermediate behaviour, with a tendency to concentrate larger intervals for smaller values of NI, and semi-tone suites of intervals for larger values of NI. This is self evident from the cases for NI=1 and NI=12, but two further examples will help the reader better understand the phenomenon:

• NI=2 in figure 36, page 197, generates six different hyper-systems in the semi-tone model which are 1 11; 2 10; 3 9; 4 8; 5 7; 6 6. In turn they generate unique systems (identical to the hyper-systems) with two sub-systems for each configuration (there are only two possibilities for combining two numbers, here taken as a and b: a b and b a). System 6 6 is fully redundant (this means that whatever de-ranking – or other combinatory – process is applied to its intervals, we end up having the same configuration because all intervals are of the same class). The total number of generated independent sub-systems for the entirety of hyper-systems for this case (NI=2) is consequently equal to 11 (fig. 36, p. 197 var. NSS_NR).

• When NI increases, the largest possible intervals become smaller in size: for NI=3 with 19 systems, (same figure) for example, the largest possible interval is the ten-semi-tones interval which appears in the first hyper-system 1 1 10 (or two intervals of one-semi-tone in a row and one ten-semi-tones interval). The size of the largest interval decreases regularly with the increase of the NI, and reciprocally that is if we increment NI by one unit, the largest interval generated is one-semi-tone smaller than for the preceding generation (with a smaller NI). When we get closer to the upper limit, the largest generated conceptual interval has decreased in such a way that only small intervals are generated: for NI=11, for example, we obtain one single hyper-system of 1 1 1 1 1 1 1 1 1 1 2 (10 semi-tones in a row and one one-tone interval), which still generates one unique (identical) system, with however eleven different subsystems generated by the de-ranking process which are:

- 1 1 1 1 1 1 1 1 1 1 2
- 1 1 1 1 1 1 1 1 1 2 1
- 1 1 1 1 1 1 1 1 2 1 1
- 1 1 1 1 1 1 1 2 1 1 1
- 1 1 1 1 1 1 2 1 1 1 1
- 1 1 1 1 1 2 1 1 1 1 1
- 1 1 1 1 2 1 1 1 1 1 1
- 1 1 1 2 1 1 1 1 1 1 1
- 1 1 2 1 1 1 1 1 1 1 1
- 1 2 1 1 1 1 1 1 1 1 1
- 2 1 1 1 1 1 1 1 1 1 1

Consequently, the last case (NI=11, fig. 36: 197) generates, with one and only hyper-system which is identical to the one and only system it generates, the same number of independent (non-redundant) sub-systems as with NI=2 above (fig. 36: 197, var. NSS_NR).

This is a first indicator of symmetry for generations with different NI. This symmetry is obvious in figure 36, page 197, (var. NSS_NR) which shows the statistical results of a full scale generation in the semi-tone model of the octave. Values around NI=6 are symmetrically placed for the numbers of systems, (var. NS) however, this symmetry does not apply to hyper-systems (fig. 38: 198, var. NH: var. NSSU_NR is explained below).

• As a next step after determining the numbers of sub-systems, we exclude redundant sub-systems from the whole set (fig. 38 and 39: 198 – this also shows the numbers of hyper-systems). Redundant sub-systems occur whenever an interval configuration is repeated twice or more in order to cover the complete range of intervals within a system. System 4 4 4 in the semi-tone model (three – or NI=3 – successive di-tones which form an octave) is completely redundant, as any de-ranking process gives the same combination as the original one (this is a mono-interval element repeated 3 times in order to form an octave).

Another example is the one-tone scale used by Debussy, 2 2 2 2 2 2 (NI=6), which is also completely redundant. More elaborated semi-redundant systems (which generate a limited number of sub-systems – such as Messiaens' scales with limited transpositions) exist, such as 1 1 2 1 1 2 1 1 2 containing three successive three-interval identical combinations of two conjunct semi-tones and one one-tone intervals (121 121 121 and 211 211 211 are independent sub-systems of the latter). There can only be three distinct sub-systems (scales).[126]

• Results for sub-systems are then expressed, for both generations (*i.e.,* with the complete or with restricted alphabets), through the Unitary number of non-redundant sub-systems, or the total number of non-redundant sub-systems divided by the corresponding NI (see for example figs. 38 and 39: 198). This process is explained in details in the following section.

• To the results of the previous process, we apply then the two following filters and keep track of the results for both, as well as for the unitary numbers of sub-systems (figs 40, and 41: 199,[127] with these filters, successful combinations are kept, not excluded):[128]

• Firstly find all sub-systems with a fourth starting with the first interval that we shall call a direct fourth. This limitation is due to the fact that a fourth, in second position, for example, in a sub-system is the first fourth of the lower ranking sub-system (by a deranking process).[129] The values on the graphics (var. NSS5U_NR, beginning with figure 40, page 199) indicate that the filtered remaining sub-systems have each a direct fifth (which starts with the first interval of the sub-system - these are labelled NSS5U_NR on the graphs,

for 'Numbers of Sub-Systems in 5th Unitary, Non redundant'). As long as we are searching for statistical results, this is the same as searching for direct fourths, as a complement of the fifth (the fourth) can be obtained by de-ranking the sub-system four times.[130] This filter keeps the filtered sub-systems, and excludes the others (as if we excluded all sub-systems that do not have a direct fourth); original results with unitary sub-systems are however kept for further comparisons.

• The next step consists in verifying for systems with a direct fourth enclosed in a direct fifth (labelled FFU_NR, or 'Fourth in a Fifth, Unitary and Non-Redundant'), for example in {(442) [4] (352). With the latter, the direct fourth is 442, and the direct fifth is {442[4]} with the complement of the fourth within the fifth being the one-tone interval, or [4] – in such cases, the configuration of the sub-system is equivalent to a combination of two fourths and a one-tone interval (4th + T + 4th – see example above). This filter is named the direct Fourth in a Fifth, or FF, process (same figures as above).

• Now that we have representative graphics for the overall statistical distribution of sub-systems, including the ones containing direct fourths and/or fifths, we may apply, separately, as a first approach, two additional filters which are very close to the ones used for the fourth and fifth containing intervals explored in the previous sections:

• The conjunct semi-tones criterion (which operates here for three or more semi-tones in a row – (figs 42 and 43: 200).[131]

• The conjunct large intervals criterion, which operates for intervals greater or equal to the one-tone-and-a-half interval (3 in semi-tones, 6 in quarter-tones (figs 44 and 45: 201).[132]

• The final stage is reached by applying the last two filters simultaneously (figs 46 and 47: 202). All these graphics and filtering procedures are discussed in the next sections.

From hyper-systems to unitary sub-systems: an example based on the semi-tone model

We shall begin our investigation of the octave with a full scale generation in the semi-tone model using the complete alphabet, from the one-semi-tone interval to the twelve-semi-tone interval. A complete generation includes statistical results for numbers of conceptual intervals NI distributed between NI=1 to NI=12: the case for NI=1 (one single octave interval in the system) is shown on the first four graphs only.

A. Generation of octave systems with the full alphabet of conceptual intervals

This first example of octave generation in semitonal conceptual intervals shows that the results in numbers of systems for NI=1 have a symmetrical correspondent which is NI=11 (fig. 36: 197). The optimal

value for systems with this process is reached for NI=6, for which the number of systems is at its highest value (80 systems are produced for this number of conceptual intervals to the octave and 480 subsystems). Furthermore, results (for systems - NS - still) for intermediate values of NI (from NI=2 to NI=10) are symmetrically distributed around the optimal value (for NI=6).[133]

However, the non-redundant sub-systems are also distributed symmetrically around the bi-optimal at NI=6,7. If we look at the numbers of hyper-systems (NH) generated by this process (fig. 38: 198)[134], they have a distribution which is different from the distribution of the number of systems (NS). This is because and, although for example NI=4 generates the largest number of hyper-systems (in this case 15), each hyper-system in this configuration can generate a limited number of systems since there are only a small number of positions (four in this case) in which conceptual intervals may be combined in order to obtain systems,[135] whenever the corresponding (symmetrical in terms of numbers of generated systems) case is NI=8, which generates a lesser number of hyper-systems and have the same number of systems because of its eight (twice more as for NI=4) possible positions for conceptual intervals. In the latter case, there are fewer possibilities for different classes of intervals within the hyper-system,[136] but more positions (eight) that conceptual intervals can fill. This explains why the results are balanced although we still have no explanation for the perfect symmetry of the resulting numbers of systems around NI=6.[137] The symmetry equally applies for the Unitary Number of Sub-Systems (NSSU), from which Non-Redundant sub-systems have been excluded (NSSU_NR on the graph in fig. 38: 198). The latter is a weighted variable which reproduces the effect of the principle of economy explained in the first section of the second part of the article. If we transpose this principle to the statistical generative models explored here, an increase of complexity (i.e., of the number of conceptual intervals, or NI, needed in order to compose the octave), even if it produces more sub-systems must bring a relative increase of the latter. In other words, each supplementary interval needed to compose the octave must be justified by a proportional (qualitative) increase of the number of generated sub-systems, not only by augmentation of the total (quantitative) number of sub-systems.

This proportional increase criterion can be included from the results by dividing the total number of sub-systems, for each NI, by the number of conceptual intervals needed in order to complete the octave, that is by NI itself, which gives us NSSU = NSS/NI. This variable (NSSU) is equivalent to NS (or the total number of systems for each different NI),[138] and gives us, as such, no additional information. However, if we exclude the redundant (R) sub-systems[139] from the total number of sub-systems, we obtain the final (weighted) variable NSSU_NR which is equal to

the total number of sub-systems minus the number of redundant sub-systems for each NI, the whole being divided by NI itself, (or NSSU_NR = (NSS - R)/NI. NSSU_NR is, as a result, a compound variable that integrates the principle of economy. It shows the need for each supplementary conceptual interval used in a scale to be justified by a proportional increase in the number or resulting sub-systems. In the graph of figure 38, page 198, the values for NSSU_NR are close to the ones expressing the total number of systems (as there are few, comparatively, redundant sub-systems in each case, except for NI=12 which is a trivial case), and the corresponding broken line is also symmetrical around NI=6.[140]

B. Generation of octave systems with reduced alphabet of conceptual intervals 1, 2, 3, compared to full alphabet generation

When we limit the largest interval in the semi-tone model to the one-and-a-half-tones interval (limited alphabet), the symmetry observed for systems and subsystems in the previous generation disappears (figs 37: 197 and 39: 198 - symmetry shifts around the bioptimal values NI= 7,8, in fig. 37: 197, for non-redundant sub-systems) and the optimal value NI for systems (NS) shifts to the value NI=7 instead of NI=6, while smaller values for NI (up to 3) simply do not generate any scale element. The smallest productive value of NI in this generation is NI=4, with the unique hypersystem/system/sub-system 3 3 3 3.[141] Furthermore, the number of pentatonic (with NI=5) systems diminishes considerably,[142] and values of NS and NSSU_NR, and NSSU_NR (fig. 39: 198) for slightly larger values of NI (NI=6 to NI=8) are also considerably reduced when compared to those of the full generation in figure 38, whenever results for still larger values of NI are less affected. Octatonic systems (NI=8) compete with the heptatonic models (NI=7) for the optimal value (especially in figure 37, where the numbers of sub-systems are not weighted) and, beginning with NI=9, generations are non-economical in all reviewed cases and figures, which means that increasing the number of conceptual intervals to more than eight in the octave gives a rapidly decreasing number of new systems.[143]

Comparing figures 38 and 39, page 198 with figuress 36 and 37, page 197 also shows that there is no direct correlation between sub-systems and systems. The optimal values are still, however, restricted to a limited number of possibilities, from NI=6 to NI=8. As a next step, we shall include the direct fourth (or direct fifth) and the fourth in a fifth filters in our models, and compare the results with those of the quarter-tone model.

Comparing generations in the semi-tone and quarter-tone models: looking for direct fourths and fifths

The direct fourth (*i.e.,* a fourth starting with the first interval of a sub-system) and the fourth in a fifth (see above) criteria may serve as supplementary filters for comparison with the remaining sub-systems. These filters are given at figures 40, page 199 (semi-tone model) and figure 41, page 199 (quarter-tone model), applied to the results of the realistic generation in the preceding stage, *i.e.,* to the unitary non-redundant[144] sub-systems with the limited intervallic alphabet of figure 37, page 197 and to its equivalent in the quarter-tone model.[145] A few remarks may be made about these results:

• The optimal value for the Unitary sub-systems occur, in both models, for NI=7,[146] although in the quarter-tone model this optimal value has a serious competitor for NI=8, with the latter being also the optimum for numbers of sub-systems including a direct fourth (or fifth), or a fourth in a fifth[147].

• The ratio of unitary sub-systems in the quarter-tone model (fig. 41, var. NSSU_NR) to the corresponding sub-systems in the semi-tone model (fig. 40: 199, var. NSSU_NR) is about 20 to 1, whenever this proportion diminishes, for sub-systems with the fourth or the fifth (NSS5U_NR – around 10 to 1), it is even less for the fourth in a fifth criterion (6 to 1 for the latter). This means that, although the semi-tone model generates considerably fewer sub-systems, the proportion of sub-systems in this model with direct just fourths, or combined fourths and fifths (fourth in a fifth criterion), is larger than in the quarter-tone model.

However, the optimal value for these sub-systems occurs for NI=8. This is because larger numbers of NI work in favour of increased numbers of semi-tones in a scale. In turn, this applies in favour of the presence of fifths or fourths in a scale.[148]

• All results for values of NI around the optimal value decrease in an almost exponential manner (for values of NI less than, or equal to, six, or greater than, or equal to, nine). This means that optimal generations are concentrated for values of NI between (and including) six and nine, which gives us a preliminary answer to our initial question in the introduction to this article. These results are, however, still not completely satisfactory, as they do not clearly show the expected optimal value for N=7. Let us remember that sub-systems in these generations may include tri-interval suites of semi-tones, or large conjunct intervals of the second, both of which do not fit with the aesthetics of modal traditional music. The results of the application for these complementary criteria are dealt with in the following section.

Using conjunct interval filters

As a complementary step towards a better understanding of heptatonic scales, excluding conjunctions of small or large intervals from the previous resulting sub-systems, seems to be a suitable filtering criterion. Since we have already shown in the sections dedicated to models of the fourth and the fifth, conjunctions of semi-tones are rare in heptatonic scales, and occur mainly between two conjunct tetrachords. The extension of the filter to three semi-tones in a row (which seems to be an non-existent combination in the scales of traditional music as we know it today)[149] makes a good aesthetical criterion when searching for generative optimal figures 42 and 43, page 200.[150] This filter is called '\umin', or exclude ultra minimal combinations – here of three – semitones in a row. In figures 44, page 200 and 43, page 201, the results for the '\umin' filter are shown separately:[151] they are independent from the '\ max(6)' – or '\max(3)' – filter, with inversed influences on the curves (figs 44 and 45: 201, for the latter): the conjunct semi-tones filter (figs 42 and 43: 200) affects only sub-systems for NI greater than or equal to 5 (compare with (figs 40 and 41: 199), with an increased effect for larger values of NI (the last three generations with NI=10, 11, 12 – in the semi-tone model – have zero values as a result)[152]. At this stage of the study, these results are obvious: semi-tones are predominant for larger values of NI, making of it a particularly effective filter.

On the far side of the alphabet, conjunct large intervals restrict combination possibilities, and make it impossible to get fourths, for example, as two conjunct one-and-a-half-tones intervals (which form a tri-tone) are already larger than the fourth (see results of the filter in figs 44 and 45: 201).[153, 154] To exclude such sub-systems with two conjunct intervals equal to, or bigger than, the one-and-a-half-tones interval we must apply the second filter, '\max(3)' or '\max(6)' (or exclude sub-systems with two or more conjunct intervals equal to – or greater than – 3 semi-tones or 6 quarter-tones).

The evolution of the curves in figures 44 and 45, apge 201, if compared with those of figures 40 and 41, page 199 is remarkable. Although it excludes conjunctions of large intervals, this filter has no effect for values of NI equal to, or greater than, 9, smaller values of this variable are the most affected with a tendency to favour the NI=8 generation as an optimal value. All systems for NI less than 5 are excluded. This may be explained by the fact that smaller values of NI facilitate the existence of larger intervals, whenever larger values of NI tend to exclude the latter from sub-systems.[155] The two filters for conjunct small (semi-tones) or big (larger than the one-and-a-half-tones interval) intervals have, when applied separately, complementary effects:

if applied simultaneously, they give most interesting results (see figs 46 and 47: 201)[156] all optimal values, for both the semi-tone[157] and quarter-tone[158] models, occur for NI=7, with neatly shaped acute angles around the latter, *i.e.,* with rapidly decreasing values as we move away from the optimal NI.

Whenever unfiltered generations of scale element show optimal values for a reduced ambitus of possible numbers of conceptual intervals to the octave (between 6 and 8 conceptual intervals to the octave), and although it is possible that, to start with, scales other than heptatonic may have been used in traditional modal music, further aesthetical (sizes of intervals and their patterns in conjunct forms) and economical (optimal productivity) considerations have stabilised this optimal value at NI=7, confirming thus the predominant role of heptatonism with this music.

Conclusion of the statistical study of the scale

Although other models and filters can be applied to the process of interval combination[159] or to particular subdivisions of modal music[160] we can draw a simple conclusion from this second part of the article. Heptatonism is, at least partly, the result of an optimisation process within interval structure of the containing intervals of the fourth, the fifth and the octave.

Synthesis

The results of the research shown in Parts I and II tend to prove that traditional choices for containing intervals such as the fourth, the fifth and the octave are not arbitrary decisions but the result of a real need for optimal melodic expression. Within the potentially infinite vertical space of pitches, melodic music seems to have followed a very rational, although intuitive and pragmatic, search for a limitation of combinations for conceptual intervals in order to arrange them as useful paradigms, notwithstanding the unlimited variations of pitches on the boundaries defined by the components of these interval combination paradigms. These variations have been the subject of endless speculations and mathematical expressions in terms, notably, of string and frequency ratios, which contributed in creating confusion between the two processes of (1) discrimination and (2) identification of intervals. The first process is mainly quantitative, whereas the second is purely qualitative. The first process is related to interval tonometry, while the second relates to the comparison of interval qualities within the frame of a scale or a melodic pattern (or formulae). These considerations led us to the formulation of new concepts including the differentiation between conceptual (qualitative) and measuring (quantitative) intervals.

Some small intervals within a combination have qualities that distinguish them, in the concept of melodic music, from others. These become stand-alone entities[161] within larger containing intervals which, in turn, have other intrinsic qualities,[162] making them a perfect receptacle for smaller conceptual intervals. With time, these larger intervals became the fourth, the fifth and the octave, because of the particular relevance of these terms in relation to their interval capacity. For these numbers of identified classes of smaller conceptual intervals, within the containing larger intervals, the number of useful paradigms is optimal, which means that the number of paradigms ready for immediate, or delayed, composition is at its maximal potential, although the number of identified smaller conceptual intervals is at the minimal which allows for their identification.

In parallel to the relative wealth of expression, the optimal numbers of conceptual intervals (within the larger containing intervals) carry other qualities, especially their ability to produce, when combining smaller conceptual intervals, unique patterns (combinations)[163] within the containing intervals. This non-redundancy among the potential musical paradigms increases the efficiency of the means available for melodic music. These characteristics make it possible today to formulate two hypothesises on (1) the process of formation of the heptatonic scale, and (2) on the new conceptual tools that may be used in the search for the possible origin of this scale.

A hypothesis for the formation of the heptatonic scale

The consonance of the fourth, the fifth and the octave seem to be the common denominator for a large variety and types of music in the world, whilst other intervals have historically been considered as dissonant.[164] This position has been supported by arithmetics (Pythagorean tetrad) or acoustics (theory of resonance) considerations. However, acoustic agreement between partial harmonics of different pitches is not the only criterion on which music is based. Although the Pythagorean tetrad is an ingenious means for ratios of the larger consonant[165] intervals, it remains, regardless that small conjunct and fluctuating intervals (dissonant) compose the immense majority of the traditional melodic repertoire related to *maqām* music.

Whereas consonance is not a real issue for these small intervals, the most important criteria, when composing melodies with a reduced span such as with most traditional music of heptatonic expression, are aesthetical adequacy and musical expressionism. Now I simply cannot imagine someone starting a musical repertoire, which would at the end of the way lead to the heptatonic meta-system of scales, with the help of interval leaps of combined fourths, fifths and/or octaves in order to arrange a couple of musical sounds together inside a melody. This

could be comparted to travelling from one's own village to the large and far away city, then following another section of the highway in order to go to the village immediately across the valley. It just does not make sense, if there is a road between the two villages. If not, it is much easier to build the road between the two villages to start with, and then try to go to the large city (the octave)[166] or, before we reach it have a break at a pleasant inn in an average sized town on the way.[167] One can also wander off the road, or take shortcuts to the next break. This is the heart of interval fluctuations within a scale. Small discrepancies in comparison to the theoretical path assigned between two pitches, due to the morphology of each performer, the organological particularities of the instrument[168], it can be the voice or any other instrument, regional or cultural differences, etc. The way in which we walk to the medium sized town may be different,[169] and the particular place within the village, our destination, may be a little bit off limits (one might take a break at a different place within the village),[170] but the destination remains the same.

Combining a few conjunct intervals and going up or down the smaller scale, we may want to change direction and decide to play other pitches corresponding to different intervals, but that would still get us to the limits of the first established path between two pitches. The more possibilities we have in order to switch from one path to another, the more pleasant is our trip whenever we need to travel around a specific region, especially whenever we may find another intermediate middle sized town in which to set base for further explorations.[171] This is the essence of modulation, or varying the paths by moving from one established pattern of pitches to another.

While improvising new ways, one must avoid perpetual change of intermediate stops; in order not to burden our fellow travellers we guide after all the explorations already undertaken. The guide may achieve the balance between complexity and expressionism, where the pleasure of reminiscence is mixed with the pleasure of perpetual discovery, and thus avoid excessive strain for the listeners.

This is the essence of *maqām* music as I came to understand it it.[172]

On this basis, the formation process of a scale seems to become evident. Starting with a single pitch, neighbouring pitches may have been explored in succession until attaining the fourth or the fifth which, because of acoustic qualities and the need to mark a pause, or start a further stage, became the new turning point of the melody. From there on, our original performer may have chosen to go back to the starting pitch, and even beyond for a few notes and then back to it, then explore the same path, or change it for the sake of varying the original melodic pattern. Therefore, in a reduced span of one containing interval and with occasional overtaking of its boundaries, the performer can have obtained an ensemble of key-patterns of interval sizes, clearly distinguishable for the ear of

his listeners which became, in time, identified qualities of intervals within this first containing interval, the fourth (or the fifth – we explore this possibility in the next section).

Further differentiation of the small identified intervals begins to seem too esoteric for the listeners, as the discrepancies will seem too small (when they are smaller than a third of a tone, or a quarter-tone) to be clearly distinguished, the performer has reached a state of balance between his musical expressionism and the listeners ability to follow his more or less subtle modifications of the melody.[173]

This is the point when spatial extension, in either of both directions must have become indispensable in order to pursue melodic composition (it may be spontaneous or delayed, as stated above). From there we have many possibilities, all of them, considering the original process of composing the fourth, leading to the same result: the heptatonic scale.

From the fourth to the octave

Possible ways of reaching the octave (or avoiding it as some *maqām* do)[174] are:

1) The exploration of the large containing octave interval in a linear manner, that is by testing conjunct intervals in succession or in alternation (in the latter case with intermediate pitches being part of the resulting scale),

2) The addition of smaller containing intervals to one another (for example two fourths and a one-tone interval, or a fourth and a fifth) and use each as an almost independent entity,

3) The expantion of a relatively small containing interval (a fourth or a fifth) by searching for successive or alternate notes inside the a) upper (or lower) fifth or fourth, the boundaries of either of the latter being the new starting point for this exploration, b) choosing any intermediate pitch in the original fourth or fifth (or any other initial configuration of conjunct intervals) and applying any of the three processes explained above, c) combining any of the above. With all these processes, the containing intervals must not be considered as imposing strictly delimited boundaries for the scale, but as indicating sizes of intervals justified by their acoustic characteristics. In other words, the three consonant containing intervals within the octave do not bind the performer (and the music), but guide him in the creative process of music composition.[175]

Whatever process the performer chooses he will reach the same conclusion. The optimal repartition for intervals within the boundaries of the three containing intervals is three to a fourth, four to a fifth, and seven to an octave. The performer may decide to avoid the aesthetics implied in the process,[176] but optimal expressivity is reached with these numbers and remains an unavoidable conclusion.

On both sides of the octave

Now that we have reached the big city and that the intermediate stops are already explored, now that one has even determined alternative routes avoiding the heart of the city or the passage into smaller, intermediate towns, the performer may decide to conclude his composition or he may wish to undertake further explorations of the space beyond the boundaries. He could decide for example to jump from one pitch to another one a fourth or a fifth apart, and then come back, or go further, in order to explore the intermediate, or upper or lower, pitches until he and his listeners are satisfied with the new voyage where he guided them.

Eventually, with the increasing number of musicians in one location, performers came together to play alternative forms, each of them exploring parallel or separate ways of getting from one point to another of the containing interval, each of them with his own morphology, instrument(s), artistic taste, and origins. Each of them would listen to other musicians' performance and support or be inspired by it, or would be supported by those and inspire them himself. This process may have induced what we call today heterophony, in the large sense of the word, it may well be that, whenever this liberty of exploration vanished and became bounded by more or less strict patterns of progression of simultaneous musical parts, or whenever the octave (or largest) containing interval became prominent in a particular musical culture,[177] another form of music came to light, the one which is today called polyphony.

Clues about the possible origin of the heptatonic scale

If culture differs from one civilisation to another, some characteristics are common almost to all. Heptatonic scales, in the historical realm of modal music, are one of these common denominators. It seems that the number of seven conceptual intervals to the octave is the result of musically shared aesthetical criteria over a large region and for a long historical period. These criteria, which may probably be further enriched, are: 1) the consistency of bi-interval combinations (the use of middle-sized conceptual intervals) within a scale, *i.e.:* avoiding successions a) of very small (like the semi-tones) or large (like the one-tone-and-a-half) elements (intervals), b) of conjunctions of very small elements (like the semi-tone and the three-quarter-tone intervals), and c) of large elements within the fourth (like adjacent 'neutral' augmented seconds or more, or alternating tones and bigger intervals in conjunction, etc., 2) the use of an optimal step, also a smallest scale interval, for interval differentiation and identification, 3) the use of a limited alphabet of intervals of the second 4) the acoustic guidance of the main three large containing intervals (the fourth, the fifth, and the octave).

Other numbers of conceptual intervals may have been used for the octave, for example when these criteria did not apply very strictly, or when the need for particular combinations arose (for example on aesthetical or social grounds).

Whenever a specific culture decided to choose a lesser number of intervals in a scale, aesthetic criteria may have varied. In pentatonic music, for example, such a limitation as the three-semi-tone interval being the greatest conjunct interval in the scale, may have been set at a higher value. This makes it more difficult to create smaller containing intervals, especially the fourth, but leaves the larger containing intervals (like the fifth and the octave) play as acoustic guides for the performer (about) unchanged.

Choosing a number of intervals larger than seven, further possibilities appear. However, they are simple extensions of the optimised octave scales (containing seven conjunct conceptual intervals), or possible loop lines around some of the aesthetic criteria listed above (for example the inclusion of conjunct semi-tones).[178]

If a culture decides that the acoustic characteristics of containing intervals are the leading criterion, the choice of the fourth may have led to the use of the intermediate neutral intervals composing it, in order to maximise its possibilities, whenever the choice of the fifth maximised the use of semi-tones, which favoured in its turn the appearance of tense diatonism (based on successions of tones and semi-tones).

The choice of the octave as the main acoustic criterion may, on the other side, have precipitated a process of equivalence between intervals with a difference of an octave (for example between a fourth and an octave-and-a-fourth), and the use of parallel lines in polyphonic music.

All of these criteria have different powers according to the culture in which they appear. The balance between them has led to different subdivisions of one main form of music, called heptatonic modality.

Later on, and in order to arrange musical systems of intervals within a coherent music theory, different civilisations have sometimes chosen different formulations, some to keep a firm connection with music performance, and some others based on a mathematical, seemingly more elegant basis, having some connections with musical practice or acoustic characteristics of musical intervals. With time theory became an entity of its own and was developed by scholars for the sake of the beauty of mathematical constructions which were confused by their promoters, and later by their followers, being a generative theory, and whenever any musical theory should first rely on practice. The mathematical expression of intervals through string ratios or through other, very small, quantifying intervals gave theoreticians the illusion that intervals do have exact sizes in performance, even if modal practice refutes this assertion. The map became the territory, whenever it should have been, at most, a conventional sketch of the territory, or a more or less precise guide within the infinite possibilities of pitches within a containing interval. In order to remain a guide, and not become a rigid yoke to musical expressivity, theoretical expressions of scales should, first of all, differentiate between quantitative and qualitative intervals, and between conceptual, quantifying and elementary intervals, in order to stay, where possible, close to music performance and far from interval quantization.

As an overall conclusion to this study, this research gives a new, plausible explanation for heptatonism as a privileged receptacle for modal scales.

Some criteria underlined in the article, like the homogeneity rule, the insistence on the fourth or fifth, or any other indication of a calibration process of the scale, may give complementary information in the search for its origin.

TABLES

1 = 1 semi-tone

1 + 1 = 2 semi-tones, or one tone

1 + 1 + 1 = 3 semi-tones, or one-and-a-half-tones

1 + 1 + 1 + 1 = 4 semi-tones or a ditone

1 + 1 + 1 + 1 + 1 = 5 semi-tones or the approximative fourth

Table 1. Interval alphabet in an approximative fourth (in semi-tones).

1 1 3 (semi-tone, semi-tone, one-and-a-half-tones) - tonic chromatic of Aristoxenus

1 3 1 (semi-tone, one-and-a-half-tones, semi-tone)

3 1 1 (one-and-a-half-tones, semi-tone, semi-tone)

1 2 2 (semi-tone, tone, tone) - 'sharp diatonic' of Aristoxenus

2 1 2 (tone, semi-tone, tone)

2 2 1 (tone, tone, semi-tone)

Table 2. Species of *genera* made from multiples of the semi-tone.

Interval size: → Genera: ↓	1	2	3	Vectors
	Number of intervals of this size contained in the *genus*			
1 1 3	2	0	1	(2,0,1)
1 3 1	2	0	1	
3 1 1	2	0	1	
1 2 2	1	2	0	(1,2,0)
2 1 2	1	2	0	
2 2 1	1	2	0	

Table 3. Capacity vectors for *genera* with semi-tones.

From scalar systems to integer numbers			Capacity vector	Hyper-system
Sub-systems	concenated number	Read		
1 1 3	1 1 3	one hundred and thirteen	(2,0,1)	113
1 3 1	1 3 1	one hundred and thirty one		
3 1 1	3 1 1	three hundred and eleven		

Table 4. Scale systems 1 1 3, 1 3 1 and 3 1 1 as integer numbers. Deriving the hyper-system.

Hyper-systems with internal composition in quartertone multiples – alphabet is composed of intervals 2, 3, 4, 5 and 6					
H.	**Value**	**NS**	**NSS**	**NSS4**	**FF**	**Remarks**
1	*2 2 2 2 4 6 6*	15	105	58	21	**Ḥijāz-Kār, "gipsy" or "chromatic" scales**
2	*2 2 2 2 5 5 6*	15	105	23	6	*Very rare: existence not confirmed as (5 2 2 6 2 5 2)*
3	*2 2 2 3 3 6 6*	30	210	54	0	*Rare: existence confirmed as (3 3 2 6 2 6 2)*
4	2 2 2 3 4 5 6	120	840	208	60	Variants of N°1
5	*2 2 2 3 5 5 5*	20	140	56	12	*Existence not confirmed to this day*
6	**2 2 2 4 4 4 6**	20	140	80	46	**Frequent: generates Ḥijāz (2 6 2 4 2 4 4)**
7	*2 2 2 4 4 5 5*	30	210	40	14	*Existence not confirmed to this day*
8	*2 2 3 3 3 5 6*	60	420	120	0	*Existence not confirmed to this day*
9	**2 2 3 3 4 4 6**	90	630	168	54	**"Regular" Ṣabā (3 3 2 6 2 4 4) and other modes**
10	2 2 3 3 4 5 5	90	630	210	54	Variants of N°1
11	2 2 3 4 4 4 5	60	420	96	36	Variants of N°6
12	**2 2 4 4 4 4 4**	**3**	**21**	**12**	**9**	**Semi-tonal "diatonism" and derivatives**
13	*2 3 3 3 3 4 6*	30	210	46	0	*Existence not confirmed to this day*
14	*2 3 3 3 3 5 5*	15	105	29	0	*Existence not confirmed to this day*
15	2 3 3 3 4 4 5	60	420	120	36	Scales are close to those of N°6
16	**2 3 3 4 4 4 4**	**15**	**105**	**30**	**18**	**Frequent: Arabian Bayāt and other modes**
17	*3 3 3 3 3 3 6*	1	7	0	0	*Existence not confirmed to this day*
18	*3 3 3 3 3 4 5*	6	42	12	0	*Existence not confirmed to this day*
19	**3 3 3 3 4 4 4**	**5**	**35**	**18**	**9**	**Frequent: Arabian Rāst and other modes**
Total	**19**	**685**	**4795**	**1380**	**385**	• H: Hyper-system (numbers in this column correspond to the rank of the hyper-system) • NS: Number of Systems in current H • NSS: Number of Sub-Systems in current H • NSS4: NSS in just fourth from tonic • FF: NSS with a just Fourth in a just Fifth from tonic

Table 5. 19 hyper-systems generated within the quarter-tone model with the limited alphabet of intervals with 2, 3, 4, 5, and 6 quarter-tones. Columns to the right of the Value column express numbers of systems or sub-systems with or without conditions (fourth or fifth), rows with colour (or grey) background underline hyper-systems which generate most of the scales described in specialised literature.

Urmawī	Transition	Quartertones	Transition	*Urmawī*
1	+ 1	2	- 1	1
2	+ 1	3	- 1	2
3	+ 1	4	- 1	3
4	+ 1	5	- 1	4
5	+ 1	6	- 1	5

Table 6. Transition from *Urmawī's* conceptual intervallic representation to the quarter-tone model, and reciprocally.

FIGURES
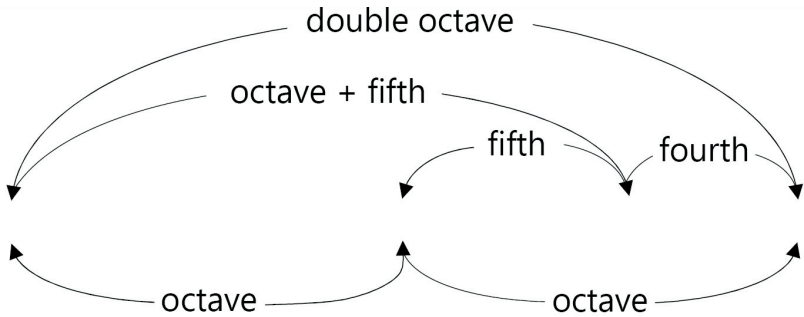
Fig. 1. Intervals resulting from the ratios between the four first integers, or tetrad. The ratios 1:2 and 2:4 give the octave; the ratio 1:4, the double octave; 1:3 the octave + the fifth; 2:3, the fifth and 3:4, the fourth. These intervals were the principle consonant intervals in Pythagorean and Aristoxenian theories. In order of their consonant quality, first comes the octave, then the fifth and lastly, the fourth.
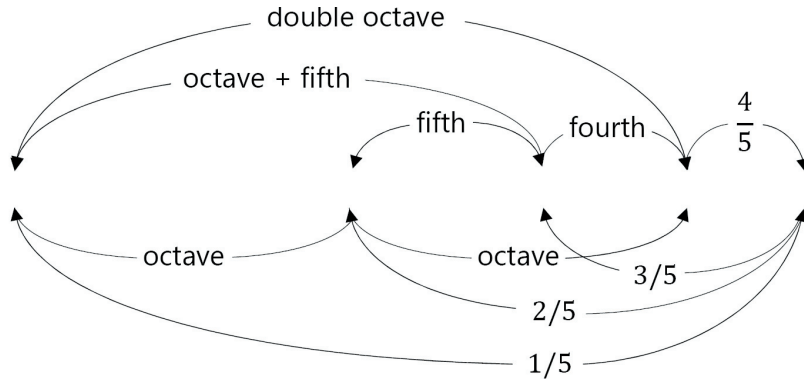
Fig. 2. The original tetrad extended to five numbers. Additional ratios include all relationships of the original four numbers with 5 added.
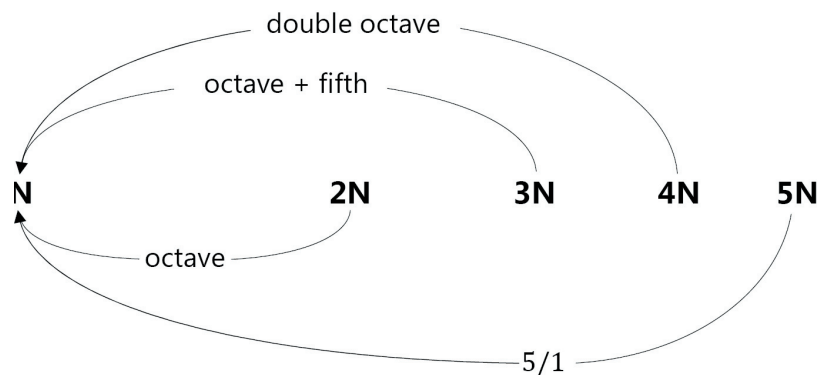
Fig. 3. In the procedure of generating notes with acoustic resonance, the pitches which result have frequencies corresponding to multiples of the fundamental to which they are uniquely related. The ratios are 2/1, 3/1, 4/1, 5/1, etc.
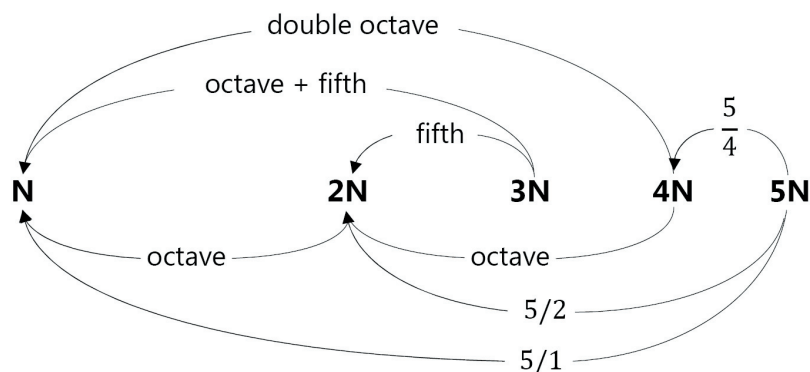
Fig. 4. Ratios for the first five harmonics with integration of successive octaves taken as equivalent pitches: the new resulting intervals include those with ratios 3/2, and 5/4 (plus 5/1 and 5/2), *i.e.* the fifth, and the harmonic third of the just intonation theory (and others).
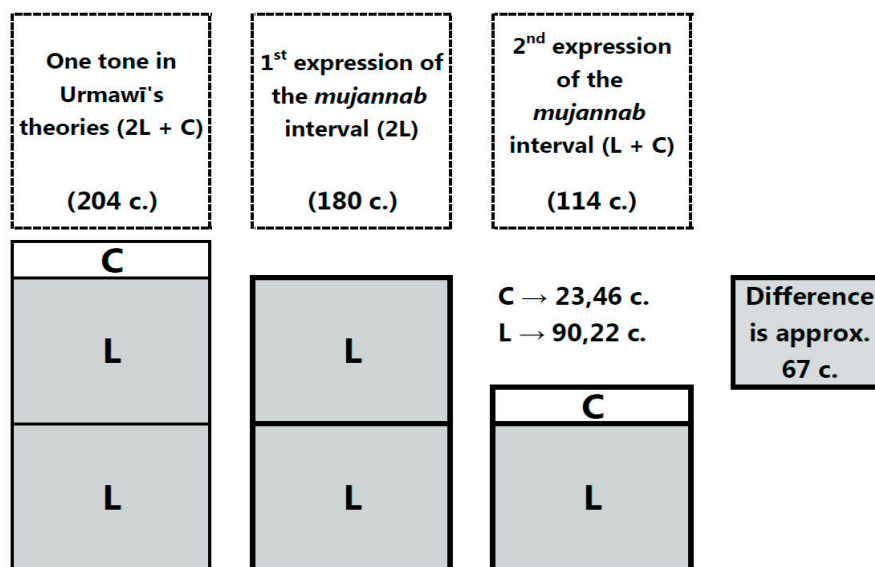
Fig. 5. *Urmawī's* tone and *mujannab.*

↓ Rāst 's ascending scale (one octave) ↓

Conceptual intervals	Conceptual intervals' capacity		Elementary quarters	Cumulative quarters
		c'		
Mujannab	3 quarter-tones		3	24
			2	23
		b⁻	1	22
Mujannab	3 quarter-tones		3	21
			2	20
		a	1	19
Tone	4 quarter-tones		4	18
			3	17
			2	16
		g	1	15
Tone	4 quarter-tones		4	14
			3	13
			2	12
		f	1	11
Mujannab	3 quarter-tones		3	10
			2	9
		e⁻	1	8
Mujannab	3 quarter-tones		3	7
			2	6
		d	1	5
Tone	4 quarter-tones		4	4
			3	3
			2	2
		c	1	1

Cumulative quarters	Elementary quarters		Conceptual intervals' capacity	Conceptual intervals
		d'		
24	4		4 quarter-tones	Tone
23	3			
22	2			
21	1	**c'**		
20	4		4 quarter-tones	Tone
19	3			
18	2			
17	1	**b♭**		
16	2		2 quarter-tones	Semi-tone
15	1	**a**		
14	4		4 quarter-tones	Tone
13	3			
12	2			
11	1	**g**		
10	4		4 quarter-tones	Tone
9	3			
8	2			
7	1	**f**		
6	3		3 quarter-tones	Mujannab
5	2			
4	1	**e⁻**		
3	3		3 quarter-tones	Mujannab
2	2			
1	1	**d**		

↑ Bāyāt's ascending scale (one octave) ↑

Fig.6. *Maqām Rāst* and *Bayāt* scales in the modern quarter-tone theory.
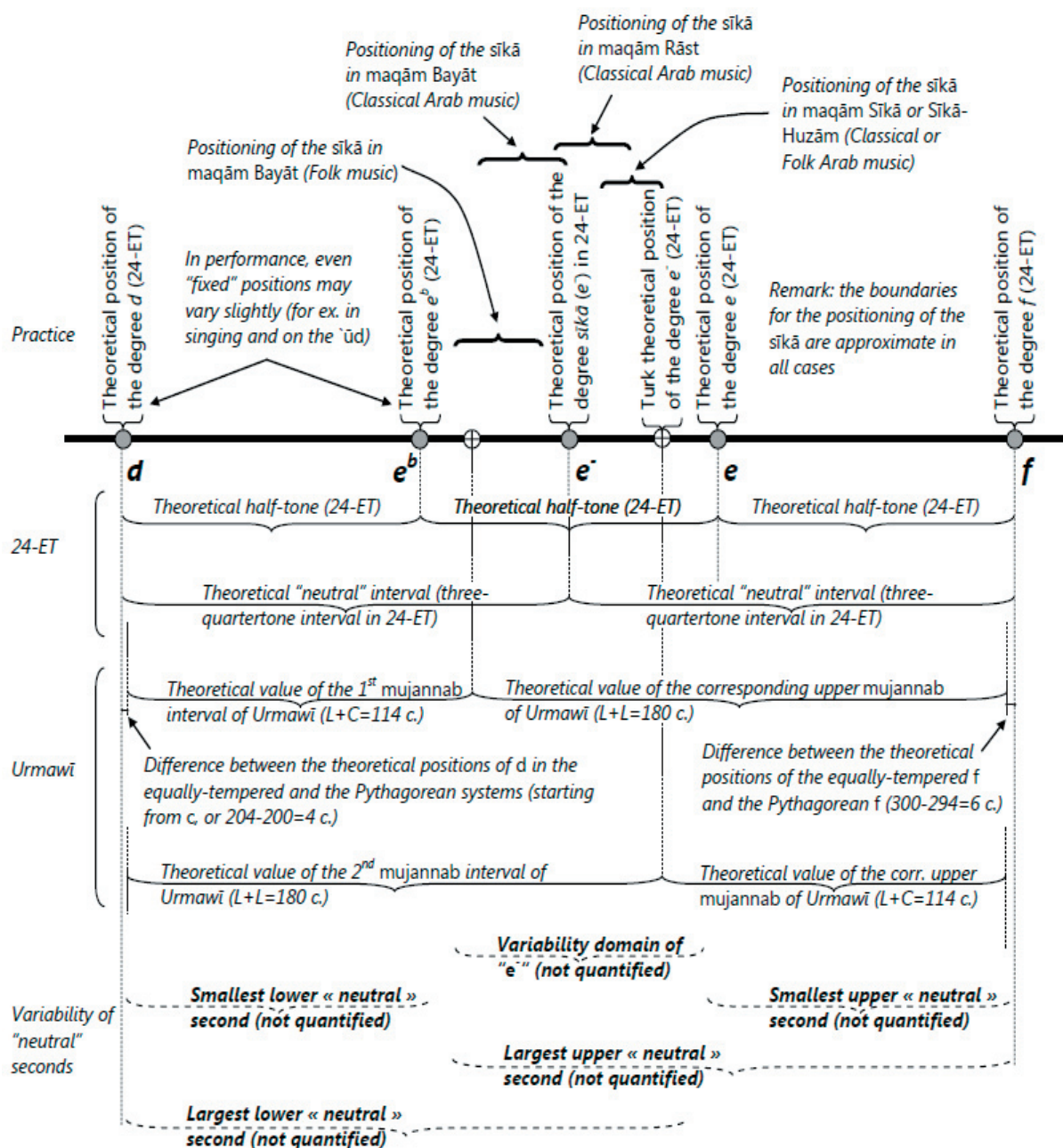
Fig. 7. Repertoire or regional variations of *sīkā* and of the 'neutral' seconds.
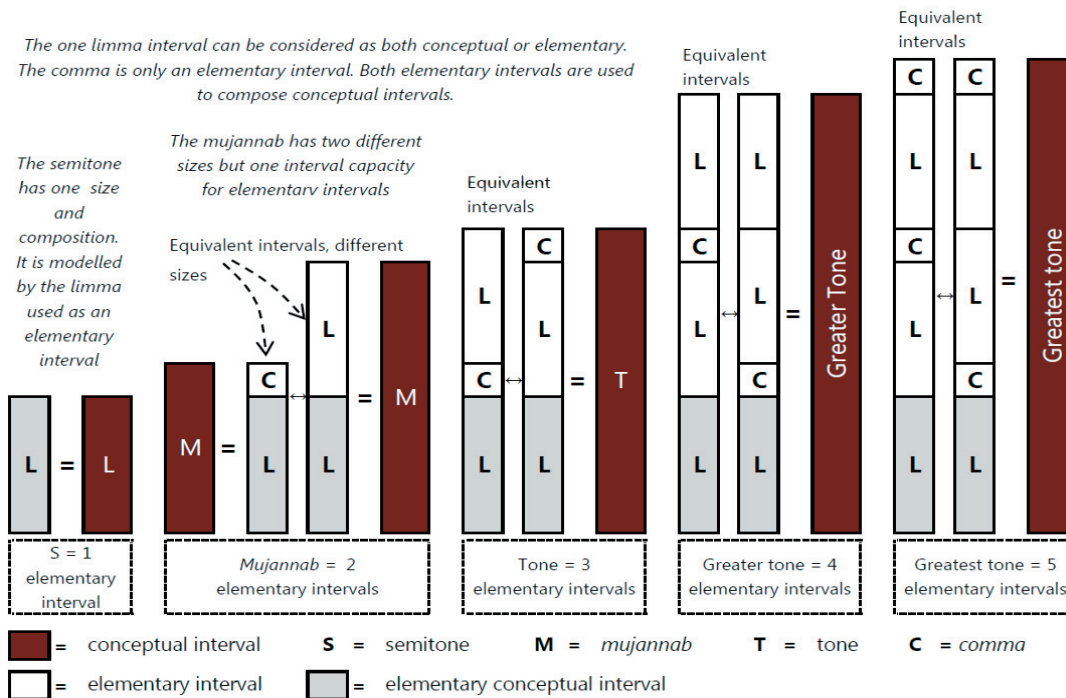
Fig. 8. Obtaining the 5 qualities of seconds in *Urmawī's* theory: the semi-tone is the smallest conceptual interval, and is modelled with a *limma*. Other intervals within the fourth are modelled from a first *limma*, augmented with a combination of *commata* and *limmata*, bearing in mind that no more than two *limmata* in a row, and no successive *commata*, may be used. The *mujannab* has two possible sizes, but contains in both cases two elementary intervals. All intervals larger than the semi-tone have two different possibilities for combinations of elementary intervals.
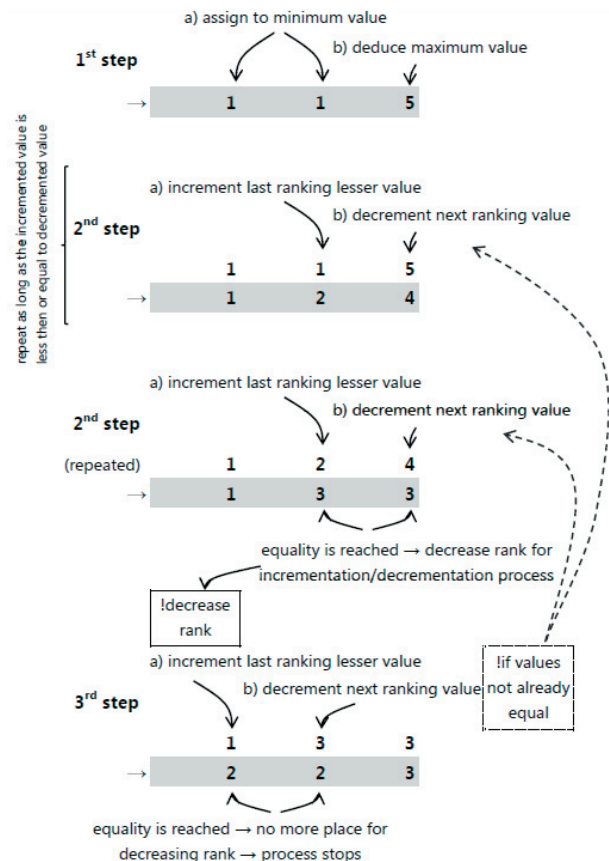
Fig. 9. Algorithm for hyper-systems.

Comb. n°1 : no rotation   a   +   b   +   c 1st rotation

Comb. n°2 : 1st rotation   b   +   c   +   a 2nd rotation

Comb. n°3 : 2nd rotation   c   +   a   +   b 3rd rotation

Comb. n°4 = comb. n°1 :   a   +   b   +   c   =   a   +   b   +   c
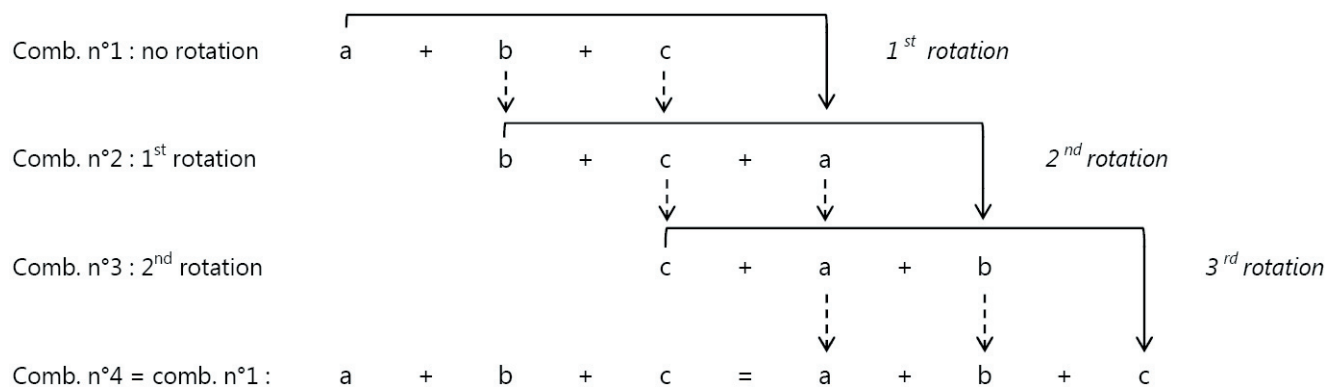
Fig. 10. Rotation of three distinct intervals a, b and c with the three resulting combinations.

Comb. n°1 : no rotation a_1 + a_2 + b_3 1st rotation

Comb. n°2 : 1st rotation a_2 + b_3 + a_1 2nd rotation

Comb. n°3 : 2nd rotation b_3 + a_1 + a_2 3rd rotation

Comb. n°4 = comb. n°1 : a_1 + a_2 + b_3 = a_1 + a_2 + b_3
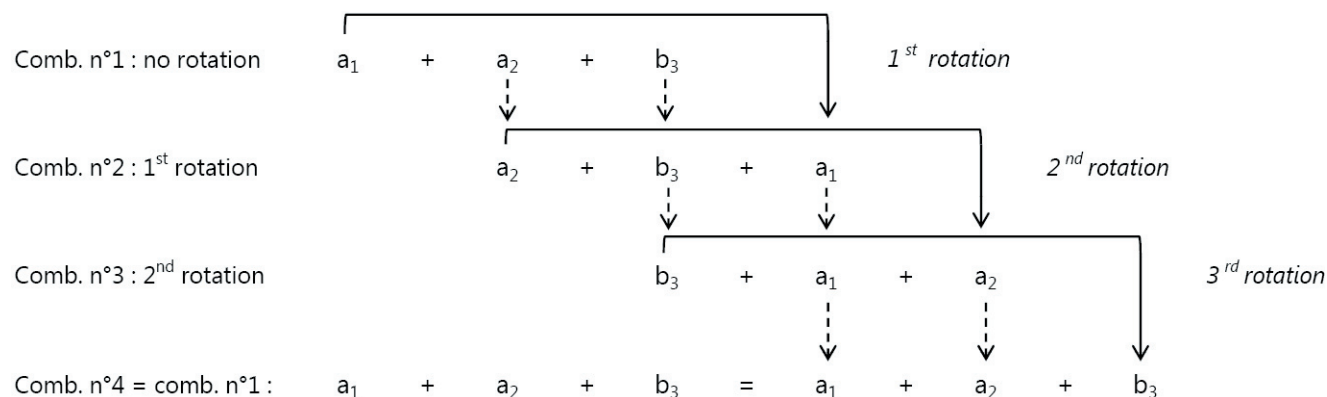
Fig. 11. Rotation of three intervals out of which two (the 'a' intervals) can be considered as equivalent (the subscript numbers identify the initial rank of each interval in the original – basic – combination): the outcome is still three distinct combinations.
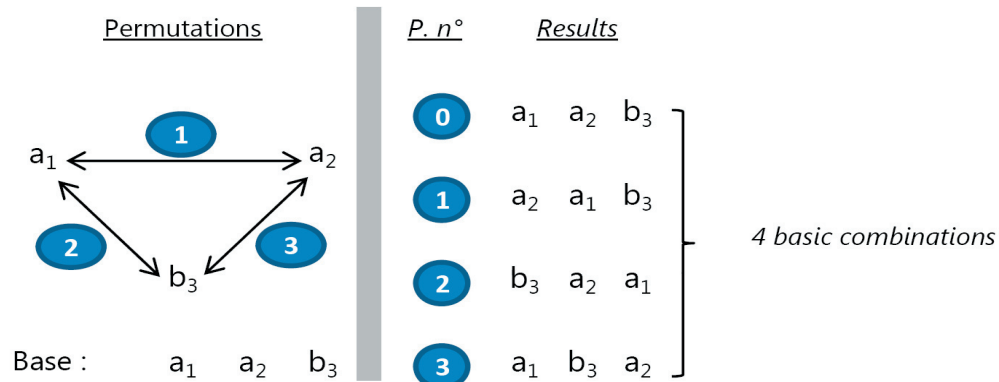
Fig. 12. Permutation of three intervals (the two "a" intervals may be considered as equal – if not, the subscript numbers, which identify the initial ranks of each interval in the original basic configuration, differentiate them): this procedure results in 4 different combinations, out of which one is redundant if the two intervals "a" be considered as equivalent.

Rotations + permutations
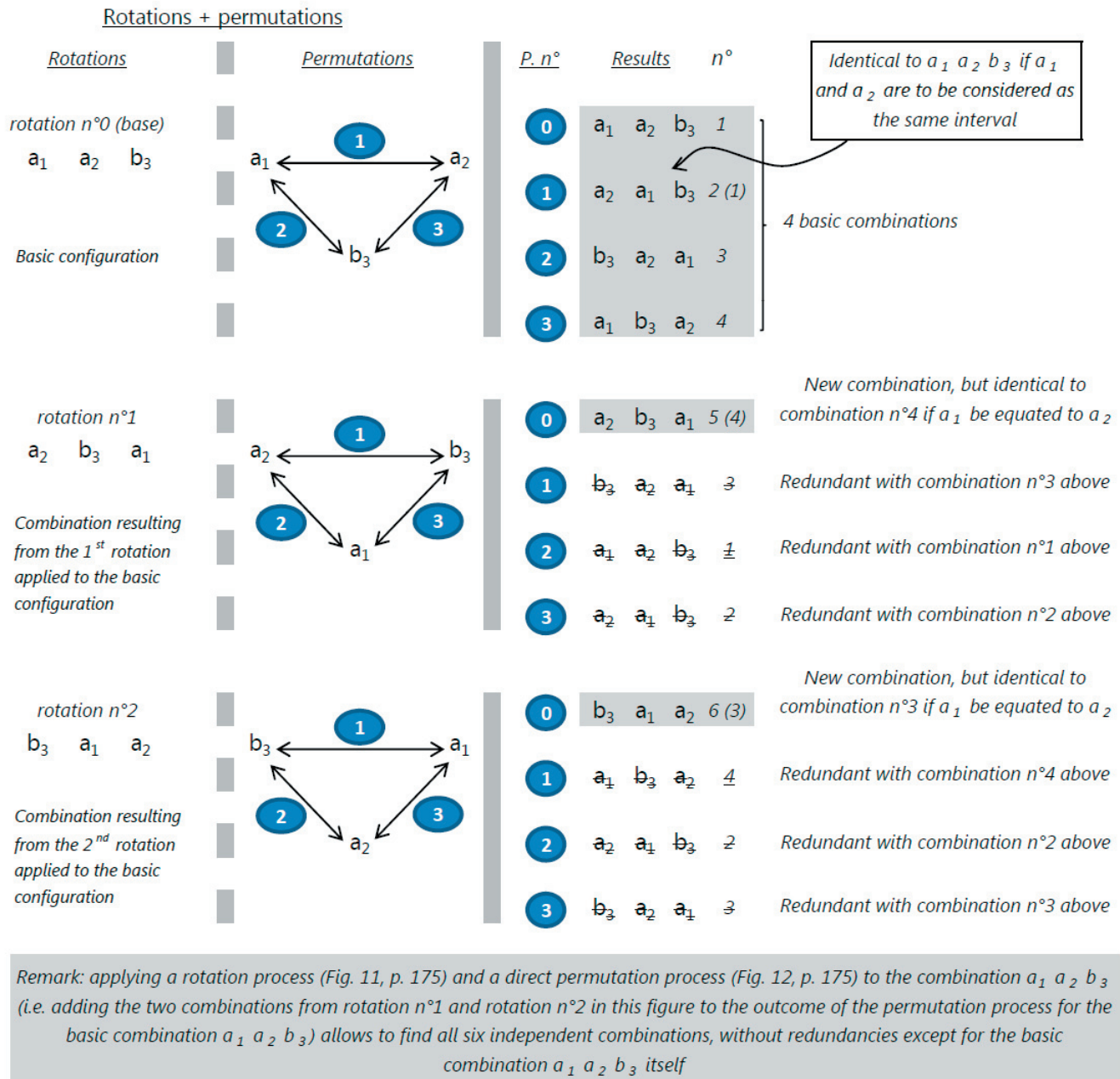
Fig. 13. Combining rotation and permutation for three intervals (the two 'a' are equal – if not, the numbers in subscript, which identify the initial ranks of each interval in the original basic configuration will differentiate them). The outcome here is 6 distinct combinations, but only 3 if 'a1' and 'a2' are identical.

1st interval	2nd interval	3rd interval	resulting combinations	n°

Initial choice between a_1, a_2 or b_3

a_1 → a_2 (remaining a_2 and b_3) → b_3 (either a_2 or b_3) → a_2

| a_1 | a_2 | b_3 | 1 |
| a_1 | b_3 | a_2 | 2 |

a_2 → a_1 (remaining a_1 and b_3) → b_3 (either a_1 or b_3) → a_1

| a_2 | a_1 | b_3 | 3 (1) |
| a_2 | b_3 | a_1 | 4 (2) |

b_3 → a_1 (remaining a_1 and a_2) → a_2 (either a_1 or a_2) → a_1

| b_3 | a_1 | a_2 | 5 |
| b_3 | a_2 | a_1 | 6 (5) |

a_2 a_1 b_3 → redundant if $a_1 = a_2$ ‖ 3 (1) → combination n°3 is redundant with combination n°1
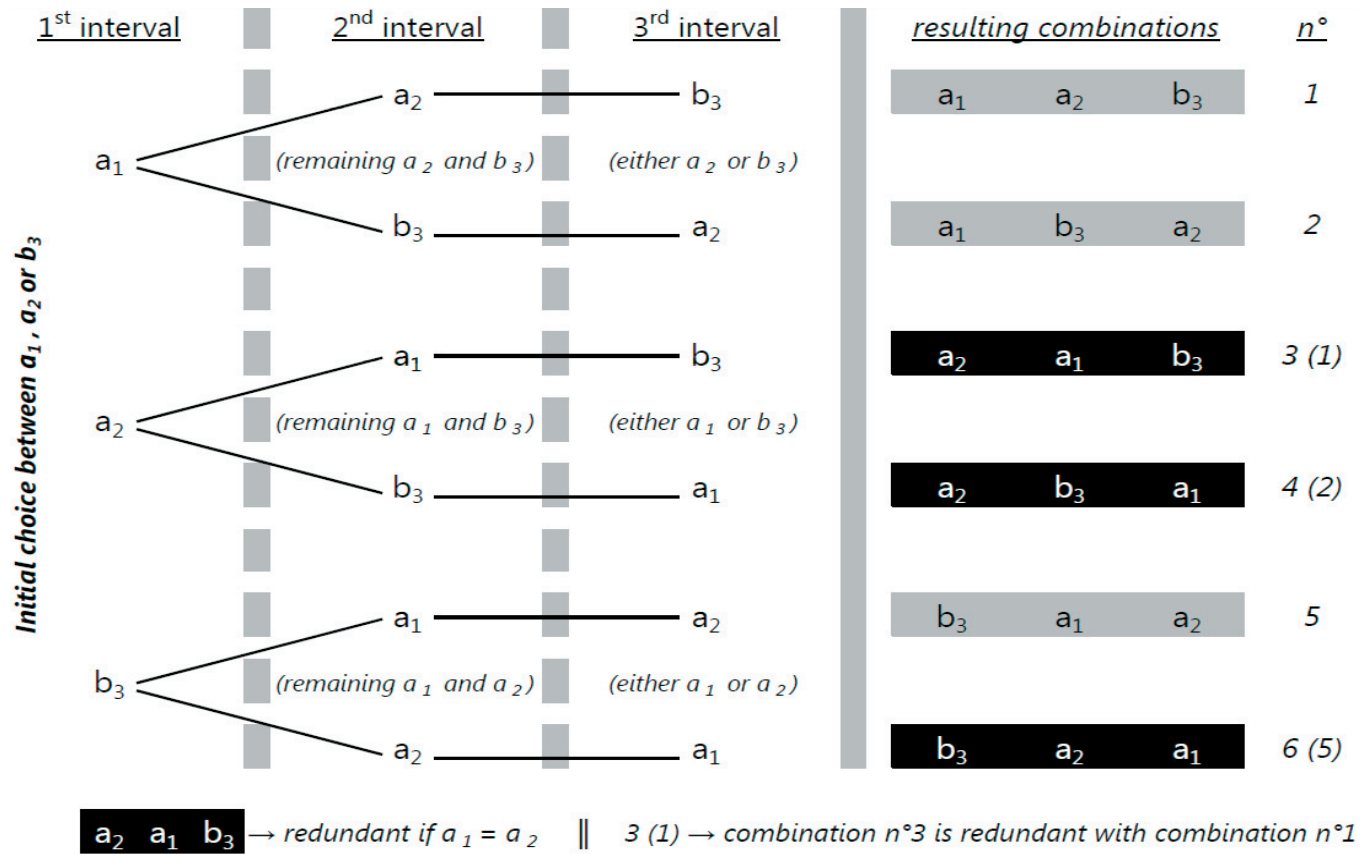
Fig. 14. Tree processing for three intervals (see previous figure). The outcome is 6 distinct combinations as in the rotation/permutation procedure, but the result is straight forward; however, if 'a1' and 'a2' be considered as identical, there would remain only three distinct combinations out of six possibilities.

Rotations	R. n°	Results	
	0	a_1 a_2 b_3	Basic combinations
	1	a_2 b_3 a_1	
	2	b_3 a_1 a_2	
	3	a_1 a_2 b_3	Redundant combinations
	4	a_2 b_3 a_1	
	5	b_3 a_1 a_2	
	. . . .		etc.

Base : a_1 a_2 b_3
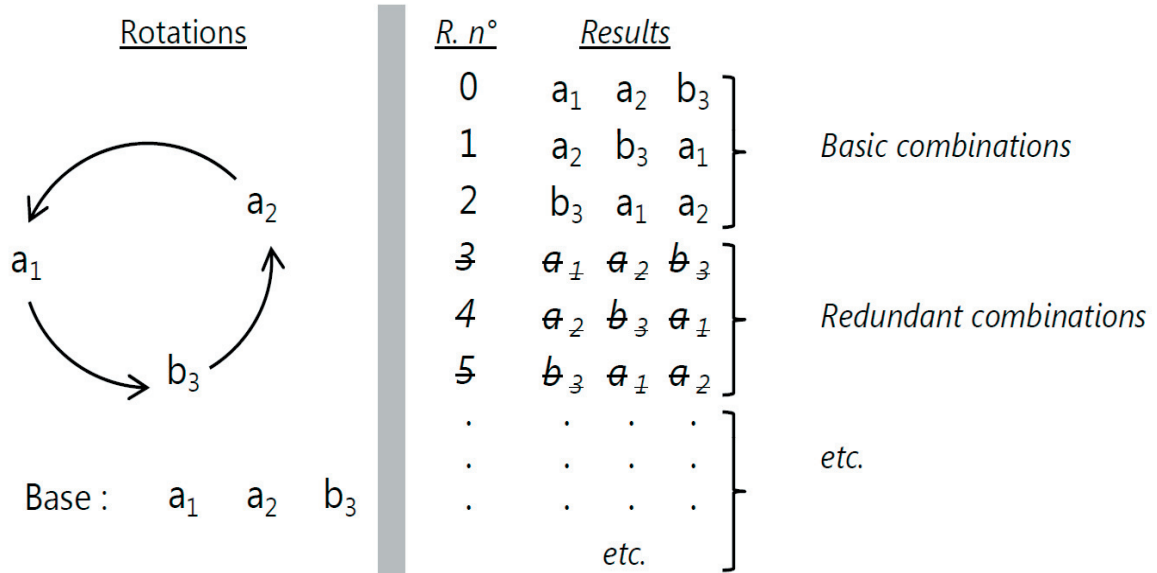
Fig. 15. Endless rotations of intervals as a particular case of the de-ranking procedure: by picking three (N) conjunct intervals, out of three ('M=N') endlessly repeated intervals, beginning with the first, then the second, etc., we end up applying a rotational procedure with, as a result, an endless series of redundant combinations.
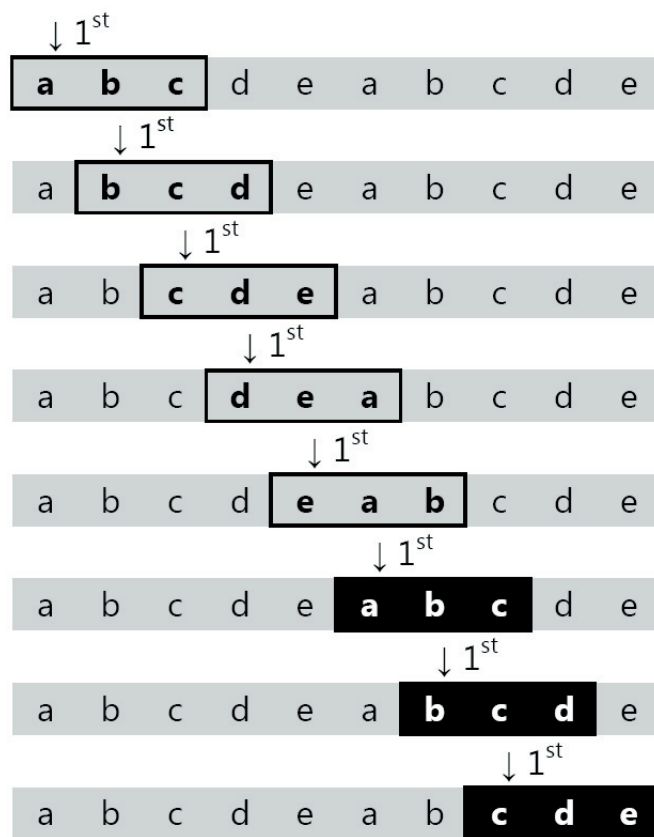
Fig. 16. De-ranking procedure applied to three successive intervals picked out from a double row of five intervals. There are five distinct combinations out of eight, the last three being redundant with the first three.
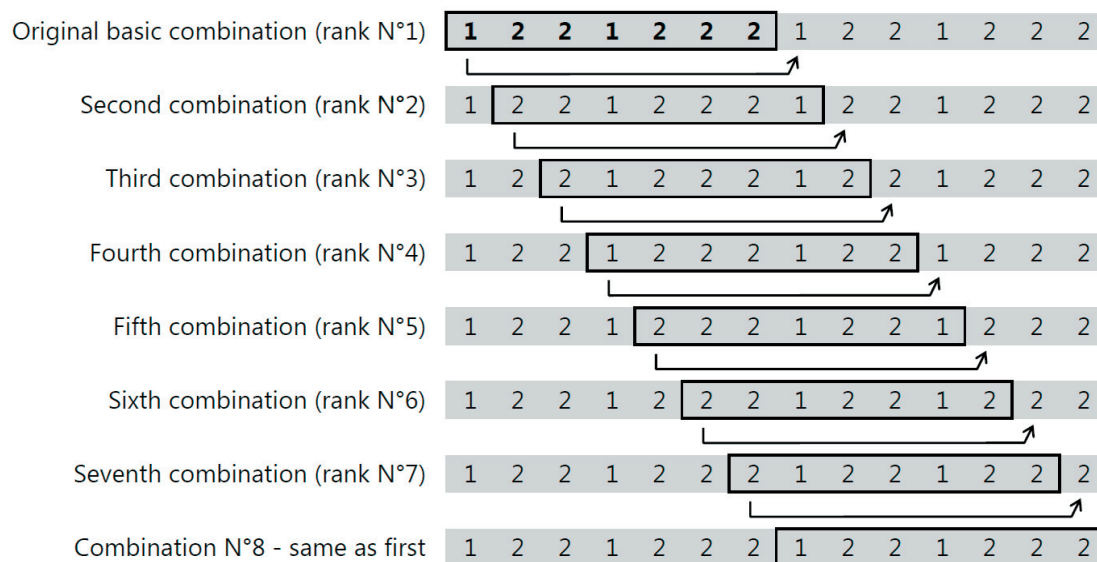
Fig. 17. De-ranking procedure applied to two identically composed octaves in a row. Seven species (or sub-systems in the theory of modal systematics) may be extracted through the procedure.

(Hyper-system is 1122222)

(Basic system has rank N°1)

The seven sub-systems (including the basic system) extracted (by a de-ranking process) from basic system 1221222

Rank of the sub-system	Beginning note (West.)	Intervals in multiples of the semi-tone						
1.	*B*	**1**	**2**	**2**	**1**	**2**	**2**	**2**
2.	*c*	2	2	1	2	2	2	1
3.	*d*	2	1	2	2	2	1	2
4.	*e*	1	2	2	2	1	2	2
5.	*f*	2	2	2	1	2	2	1
6.	*g*	2	2	1	2	2	1	2
7.	*a*	2	1	2	2	1	2	2

Fig. 18. With the de-ranking procedure applied to the western diatonic scale, the sub-system having the smallest figure as a whole number (as an integer concatenated form), is sub-system 1 2 2 1 2 2 2 (in concatenated form 1221222, or 'one million two hundred and twenty one thousands and two hundred twenty-two'). All other sub-systems have a corresponding integer value that, if their intervals be concatenated to form an integer number, is larger than the former. Consequently, in modal systematics, the combination 1 2 2 1 2 2 2 holds the head rank among these 7 sub-systems and is considered as being the basic system from which the six others are deduced by the de-ranking procedure (the basic system is, besides being the head or base system, the first sub-system in the group of seven). The capacity indicator of these sub-systems is hypersystem 1 1 2 2 2 2 2 (two one-semi-tone and five one-tone intervals).

Hyper-system: 1122222

System N°1: 1122222 — No corresponding "regular" Western scale

Rank of the sub-system	Intervals in multiples of the semi-tone						
1.	**1**	**1**	**2**	**2**	**2**	**2**	**2**
2.	1	2	2	2	2	2	1
3.	2	2	2	2	2	1	1
4.	2	2	2	2	1	1	2
5.	2	2	2	1	1	2	2
6.	2	2	1	1	2	2	2
7.	2	1	1	2	2	2	2

System N°2: 1212222 — No corresponding "regular" Western scale

Rank of the sub-system	Intervals in multiples of the semi-tone						
1.	**1**	**2**	**1**	**2**	**2**	**2**	**2**
2.	2	1	2	2	2	2	1
3.	1	2	2	2	2	1	2
4.	2	2	2	2	1	2	1
5.	2	2	2	1	2	1	2
6.	2	2	1	2	1	2	2
7.	2	1	2	1	2	2	2

System N°3: 1221222

Rank of the sub-system	Beginning note (West.)	Intervals in multiples of the semi-tone						
1.	*B*	**1**	**2**	**2**	**1**	**2**	**2**	**2**
2.	*c*	2	2	1	2	2	2	1
3.	*d*	2	1	2	2	2	1	2
4.	*e*	1	2	2	2	1	2	2
5.	*f*	2	2	2	1	2	2	1
6.	*g*	2	2	1	2	2	1	2
7.	*a*	2	1	2	2	1	2	2

Fig. 19. Complete listing of the systems and sub-systems related to hyper-system 1 1 2 2 2 2 2 (in multiples of the half-tone): three systems are generated, one of which applies to the western regular scale (semi-tonal diatonic). The other two scale systems (or seven sub-systems for each system) are rarely used but are found in the specialised literature and used in contemporary music (see Beyhom, A., systématique modale, Vol. 3: 48-50 for more details).

Fig. 20. *Urmawī's genera* within the fourth (the two hyper-systems below) and additional potential *genera*, in both conceptual (qualitative) interval modelling (left) and quarter-tone approximation model (right). The *genera* of *Urmawī* represent the full potential of the related hyper-systems; additional *genera* (and hyper-systems) exist only partly in literature (and practice) of traditional Arabian music.

Fig. 21. Measurement, elementary, conceptual and containing intervals in the quarter-tone model. This figure introduces the concept of auxiliary intervals, *i.e.*, smaller conceptual intervals which if combined with elementary intervals may be thought of as composing larger conceptual intervals, such as the neutral augmented second, which has five quater-tones and which can ce conceived as made up of a one-tone interval plus one elementary interval, that is a quarter-tone.
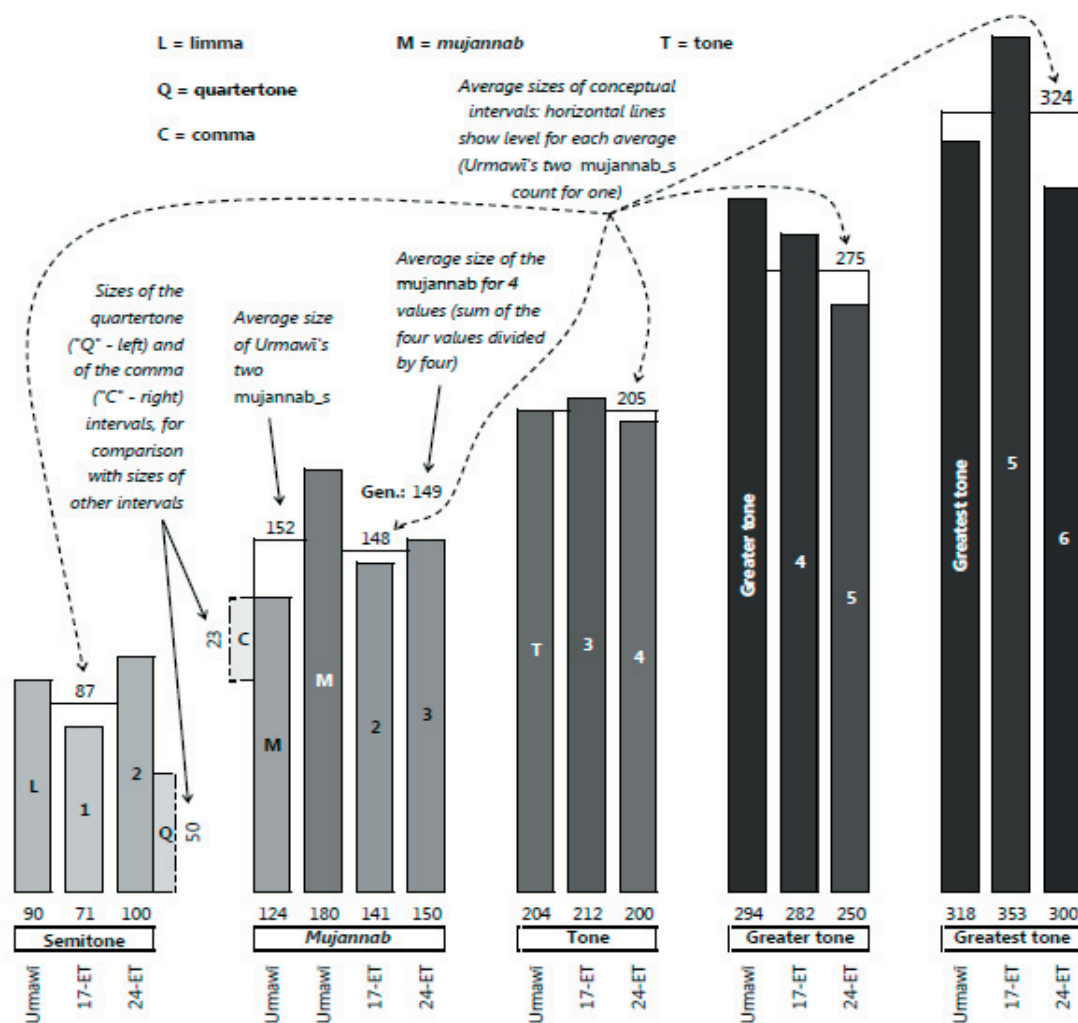
Fig. 22. Conceptual intervals from Pythagoras and *Urmawī's* 17-ET and 24-ET models. Averages show that the transition from one conceptual interval to another, respectively 61, 57, 70, 49, with the average value of 59, can be modelled either by the one-seventeenth of an octave, 71 cents, or the quarter-tone interval of 50 cents. The usage of *comma* and *limma* in *Urmawī's* model accentuate the unevenness with neutral intervals, the *mujannab* and the greater tone – the neutral augmented second.

Semitone model

Rank of HS	NI = 2			NI = 3			NI = 4			NI = 5		
	HS	S	SS	HS	S	SS	HS	S	SS	HS	S	SS
1	14	14	14>, 41>	113	113	113*, **131**, 311*	1112	1112	1112*, 1121*, 1211*, 2111*	11111	11111	11111*
(2)												~~11111*~~
2 (3)	23	23	23§, 32§									~~11111*~~
2 (4)				122	122	**122, 221, 212**						~~11111*~~
(5)												~~11111*~~
Total	2	2	**4**	2	2	**6**	1	1	**4**	1	1	**5**
Total non redundant (-)			(-0) 4			(-0) 6			(-0) 4			(-4) 1
Double semitone criterion (*)			(-0) 4			(-2) 4			(-4) 0			(-5) 0
Conjunct big intervals (§)			(-2) 2			(0) 6			(-0) 4			(-0) 5
Intersecting criteria 1 (OR)			**(-2) 2**			**(-2) 4**			**(-4) 0**			**(-5) 0**
Large intervals			*(-2)*			*(-0)*			*(-0)*			*(-0)*
Small conjunct different intervals			*(-0)*			*(-0)*			*(-0)*			*(-0)*
Intersecting criteria 2			**(-4) 0**			**(-0) 4**			**(-4) 0**			**(-5) 0**

Quartertone model

Rank of HS	NI = 2			NI = 3			NI = 4			NI = 5		
	HS	S	SS	HS	S	SS	HS	S	SS	HS	S	SS
1	28	28	28>, 82>	226	226	226*, **262**, 622*	2224	2224	2224*, 2242*, 2422*, 4222*	22222	22222	22222*
2	37	37	37>, 73>	235	235	235, **352**, 523	2233	2233	2233*, 2332, 3322*, 3223*			~~22222*~~
(2) 3	46	46	46§, 64§		253	**253**, 532, 325		2323	2323, 3232, *2323*, *3232*			~~22222*~~
4	55	55	55§, ~~55~~§	244	244	**244, 442, 424**						~~22222*~~
(4) 5				334	334	**334, 343, 433**						~~22222*~~
Total	4	4	**8**	4	5	**15**	2	3	**12**	1	1	**5**
Total non redundant (-)			(-1) 7			(-0) 15			(-2) 10			(-4) 1
Double semitone criterion (*)			(-0) 8			(-2) 13			(-7) 5			(-5) 0
Conjunct big intervals (§)			(-4) 4			(0) 15			(-0) 12			(-0) 5
Intersecting criteria 1 (OR)			**(-4) 4**			**(-2) 13**			**(-9) 3**			**(-5) 0**
Large intervals			*(-4)*			*(-0)*			*(-0)*			*(-0)*
Small conjunct different intervals			*(-0)*			*(-4)*			*(-8)*			*(-0)*
Intersecting criteria 2			**(-8) 0**			**(-6) 9**			**(-12) 0**			**(-5) 0**

Fig. 23. Combinations and filters in the frame of a fourth containing interval: HS = Hyper-system, S = system(s), SS = sub-systems.
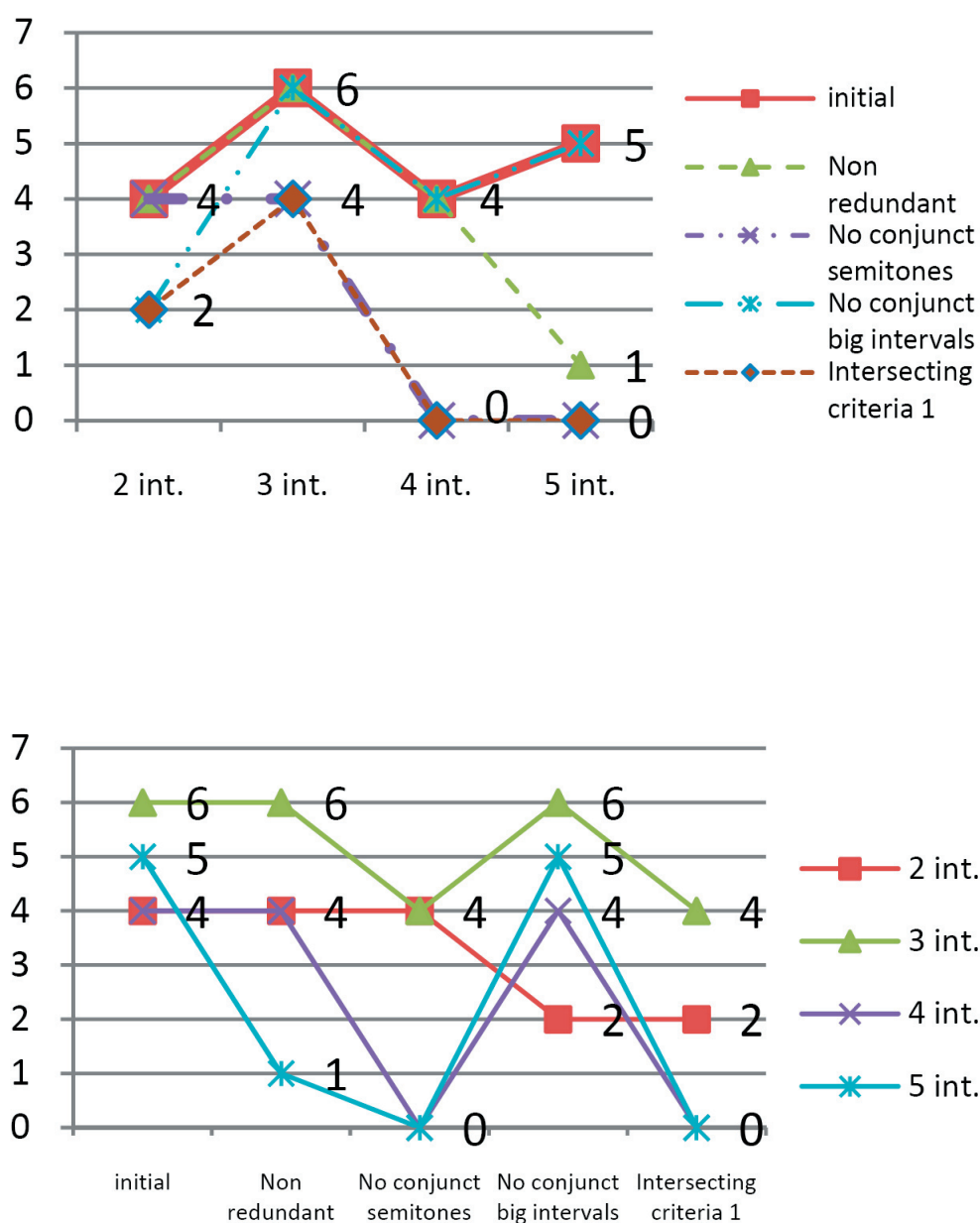
Fig. 24. Graphs of the distribution of sub-systems in a fourth, in relation with the number of intervals (conceptual conjunct intervals of second) in the scale element (above), and in relation with applied filters (below – cross-reference) for each case (NI = 2, 3, 4 and 5) – semi-tone model (results for filtered sub-systems should be compared to the values of the non-redundant line on the top-most graph, and to the corresponding values on the bottom one).
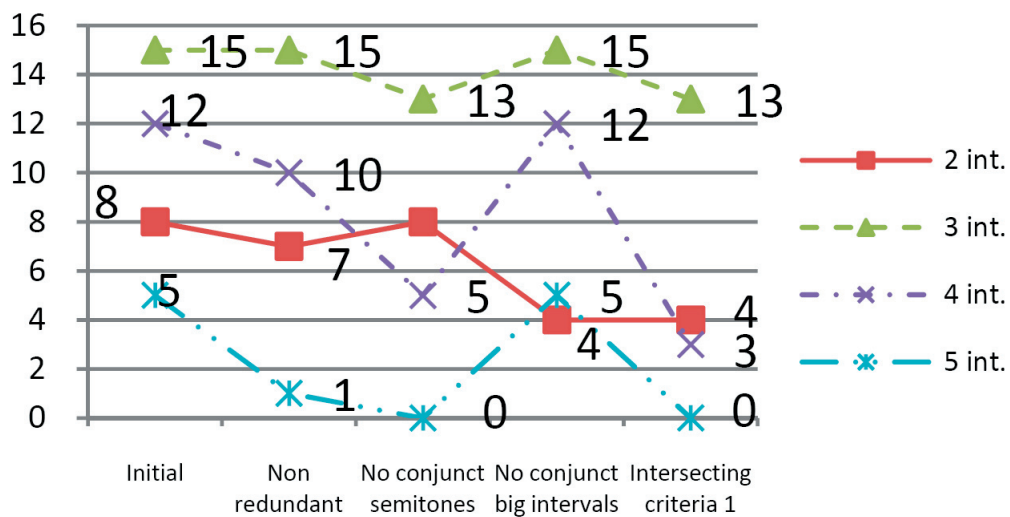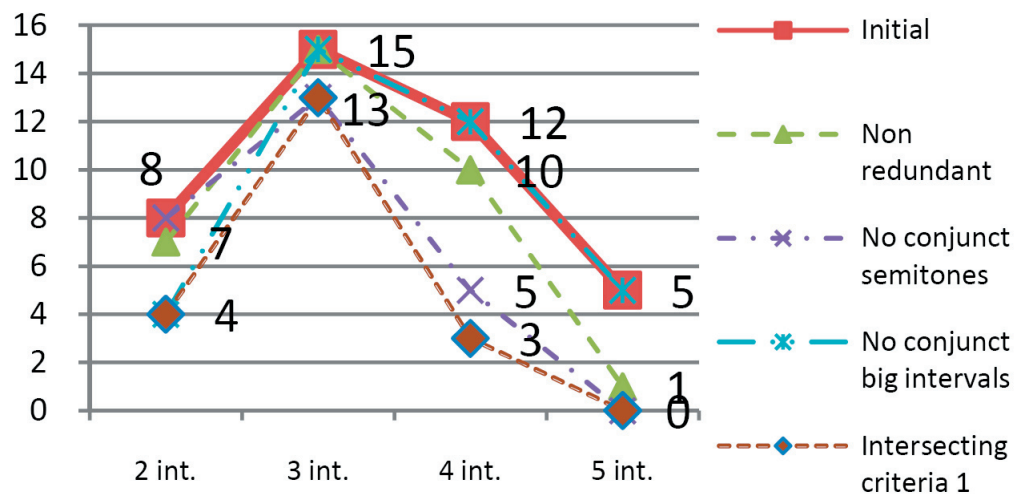
Fig. 25. Graphs of the distribution of sub-systems in a fourth, in relation with the number of conjunct conceptual intervals of second (NI) in the scale element (above), and (below) in relation with filters (cross-reference) applied in each case (NI=2, 3, 4 and 5). Quarter-tone model (compare with fig. 24 above).
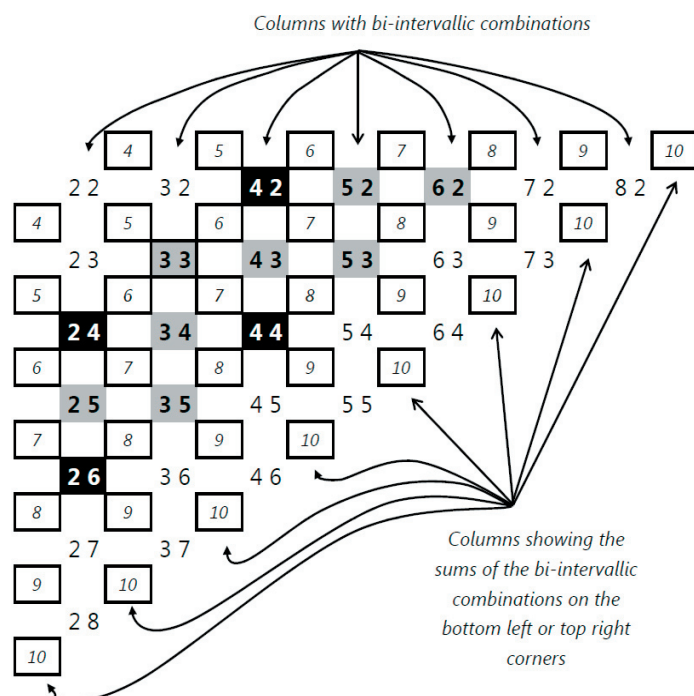
Fig. 26. Bi-interval elements of the generation for a containing interval of fourth in the quarter-tone model. Commonly used combinations are concentrated in (and occupy completely) the sector where sum values are comprised between 6 and 8 (both values included) – on black background: diatonic combinations; on black or grey background: Arabian combinations.
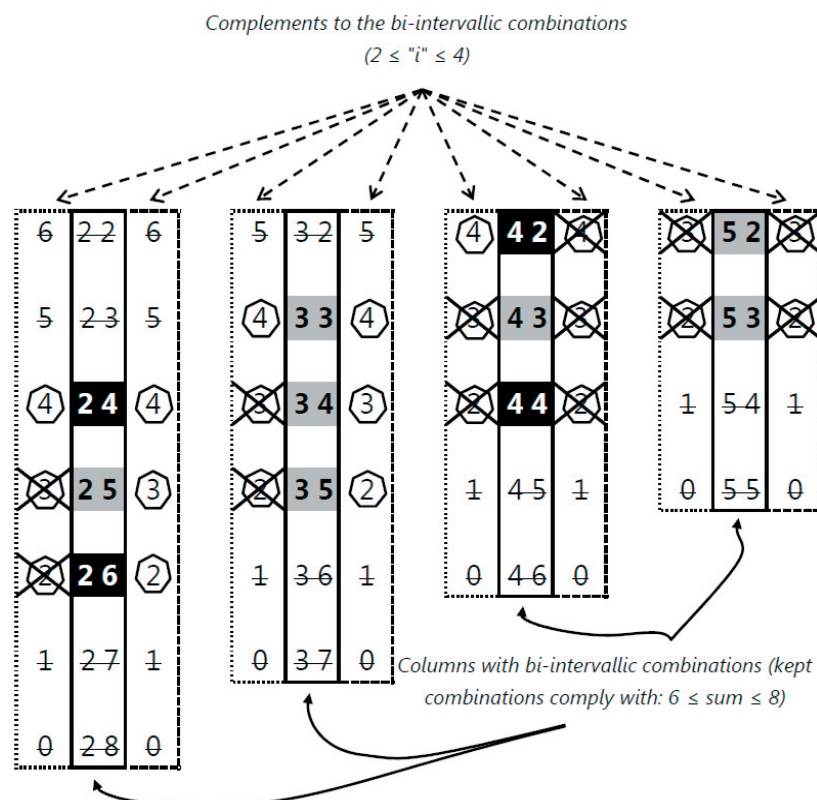
Fig. 27. Complements to the bi-interval elements of common use (black or grey background) on both sides of the elements, in order to obtain one tetrachord on each side. After redundant combinations (crossed intervals) are excluded, and by eliminating all combinations that do not comply with the homogeneity rule (which states that the sum of any two conjunct intervals must be such as 6 ≤ sum ≤ 8) and its corollary (complement value to any two conjunct intervals is such as 2 ≤ i ≤ 4 – where i is the complement value), the only remaining tetrachords in fourths are the commonly used tetrachords in both diatonic (semi-tone based – on black background in the figure) and Arabian music (both grey and black background).
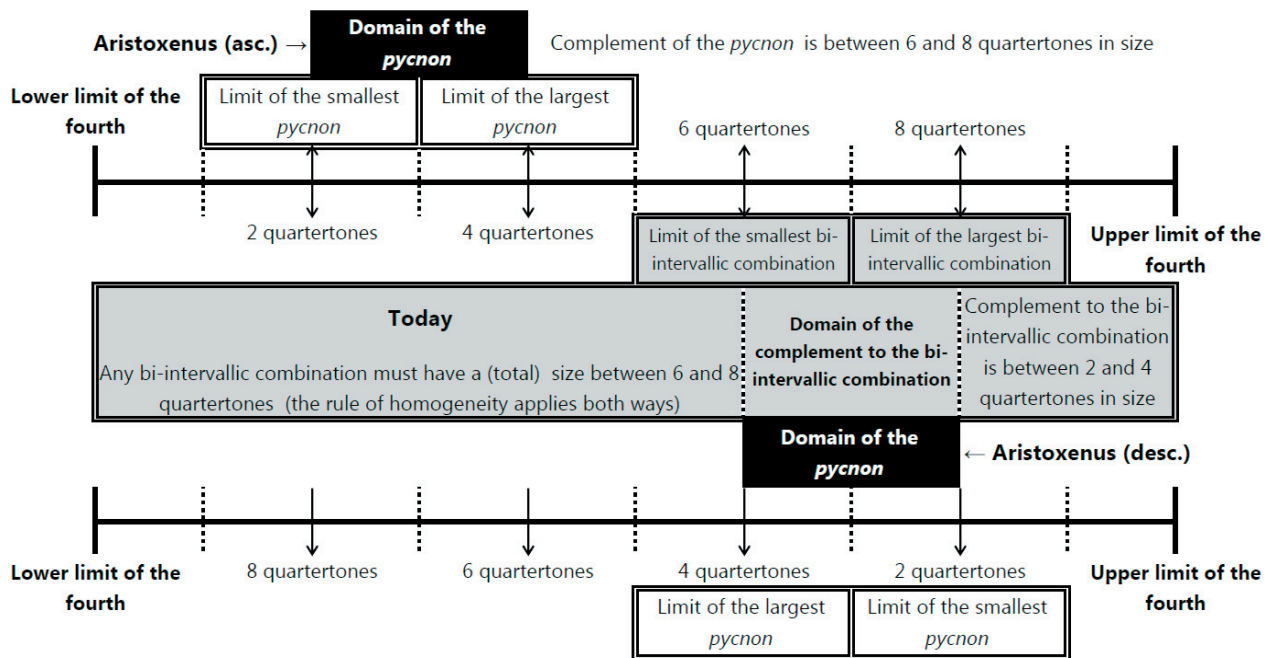
Fig. 28. The homogeneity rule, or reverse pycnon rule. If Aristoxenus' *genus* is falling, the domain of the *pycnon* is the domain of the complement of the bi-interval combination (within a fourth) in today's traditional heptatonic modal music. This applies to all *genera* in fourth of common use in Arabian music, including the chromatic *genus ḥijāz* (the symmetrical 262 in multiples of the quarter-tone) and its (most probably) original forms in 352 and 253 (the latter is more related to the *ḥijāz-kār maqām*).

Fig. 29. Extending the homogeneity rule to the fifth: names of *genera* in Arabian music stand below the tri-interval combinations. Names of the resulting pentachords in fifth (sum=14) figure at the sides of the successful combinations (diatonic combinations have a black background – left. Arabian configurations have a grey background - right). Different names for 4244 result from different positions of the tetrachord in the general scale of Arabian music theoretical literature; 3524 exists in one single and doubtful reference – the conclusion is that common pentachords in Arabian music are based on the fourth + one tone configuration, with one of the successful combinations ([4]253) not found in the reviewed literature.
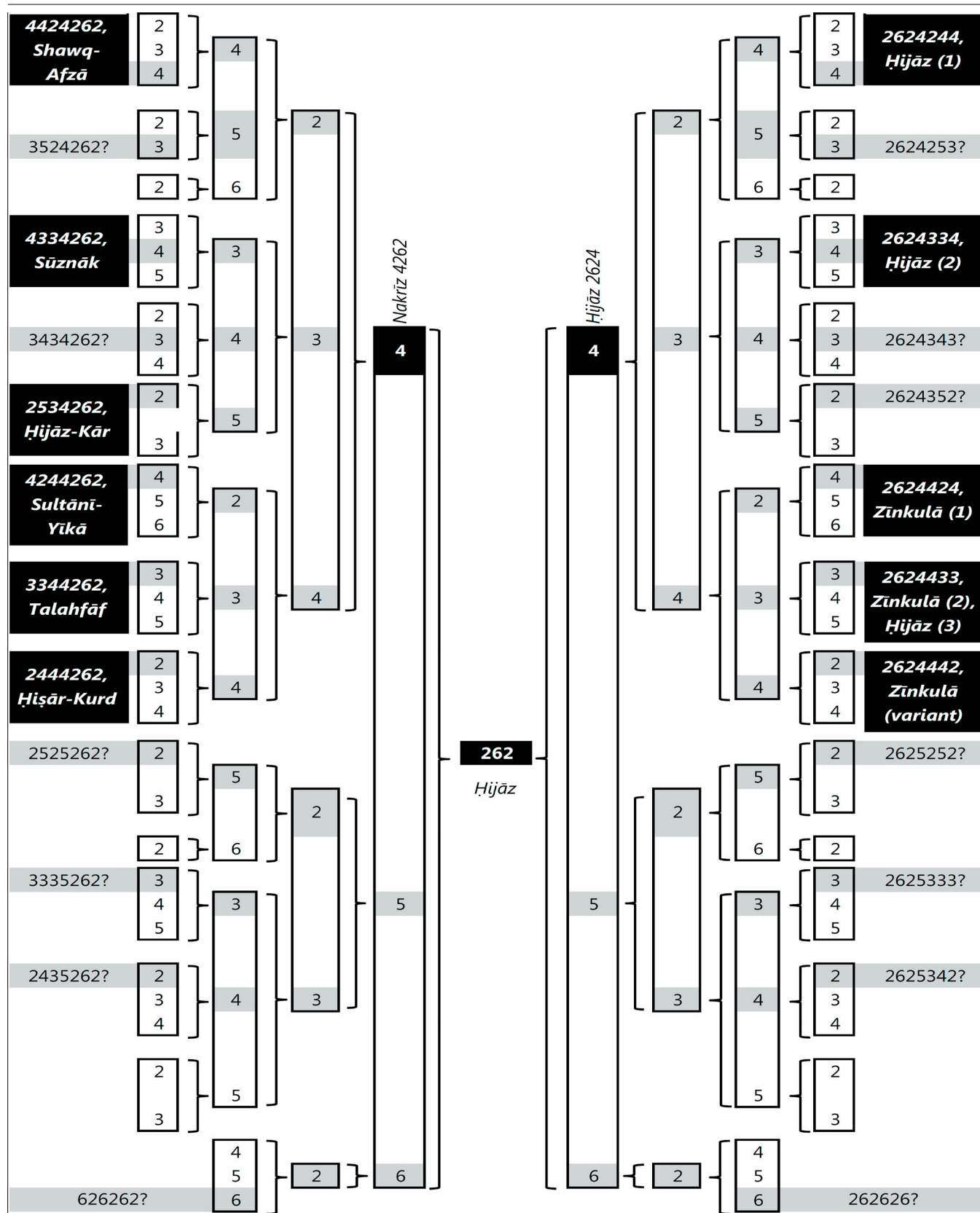
Fig. 30. Extending the homogeneity rule to the octave using tree processing of intervals, on the example of an initial *ḥijāz genus*. In case of success (the homogeneity rule is respected), intervals figure on a grey background, and names of resulting scales of Arabian *maqām* stand at the side of each attested combination (black background).
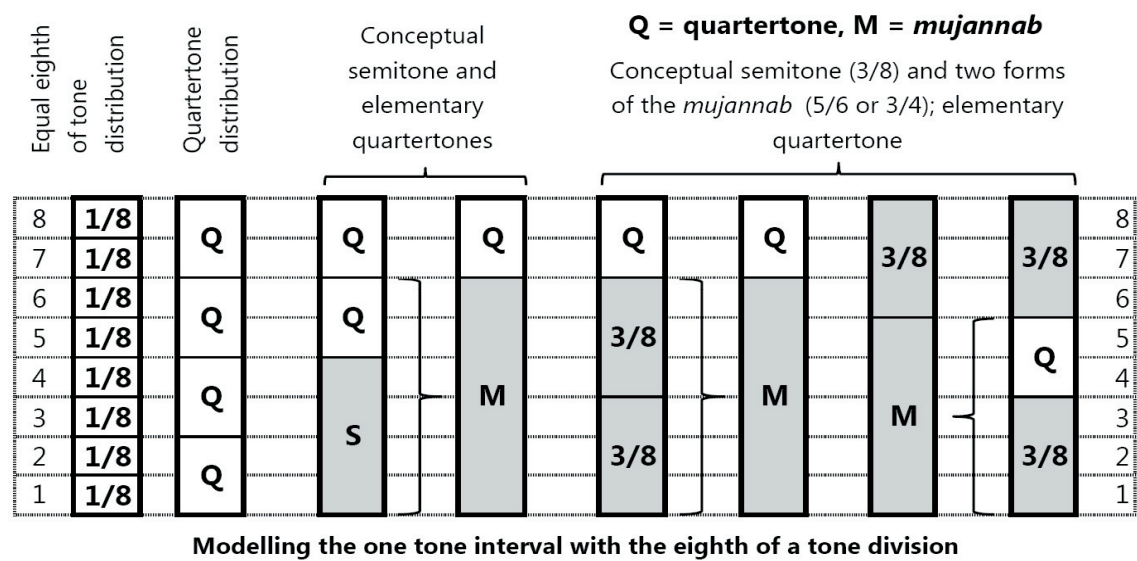
Modelling the one tone interval with the eighth of a tone division

Fig. 31. Modelling the one-tone interval with eighths of a tone.

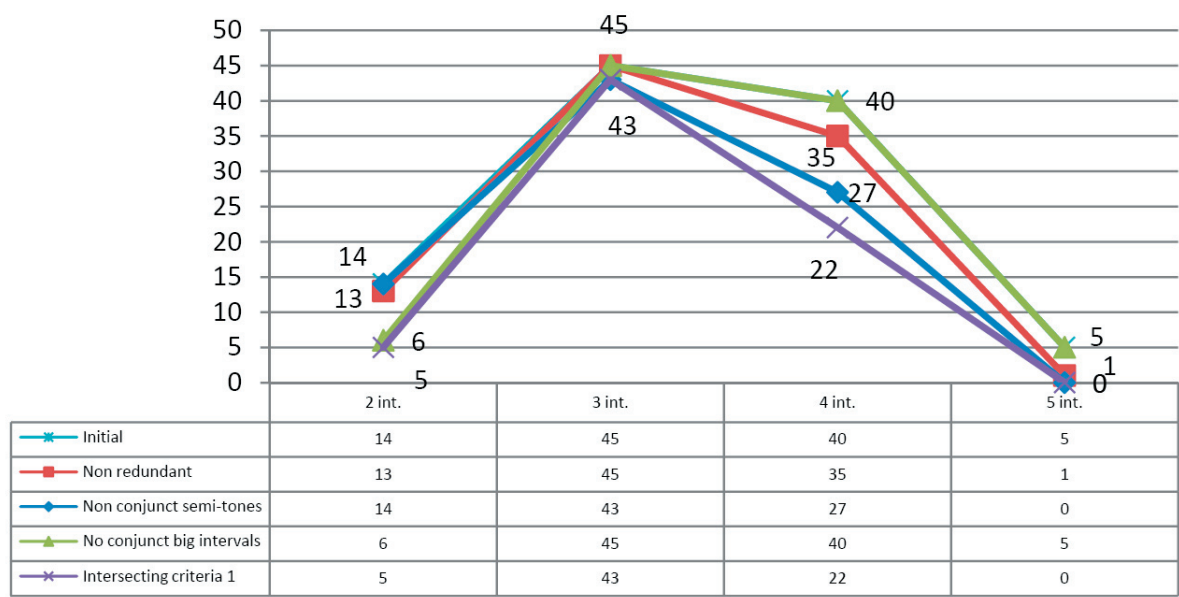|	2 int.	3 int.	4 int.	5 int.
Initial	14	45	40	5
Non redundant	13	45	35	1
Non conjunct semi-tones	14	43	27	0
No conjunct big intervals	6	45	40	5
Intersecting criteria 1	5	43	22	0

Fig. 32. Results of the generation for a just fourth in eights of the tone, with the smallest conceptual interval chosen as the semi-tone (= one half-tone).

	2 int.	3 int.	4 int.	5 int.	6 int.	7 int.
Initial	6	15	20	15	6	7
Non redundant	6	15	20	15	6	1
No conjunct semitones	6	13	18	8	0	0
No conjunct big intervals	0	6	16	15	6	7
Intersecting criteria 1	0	6	16	8	0	0

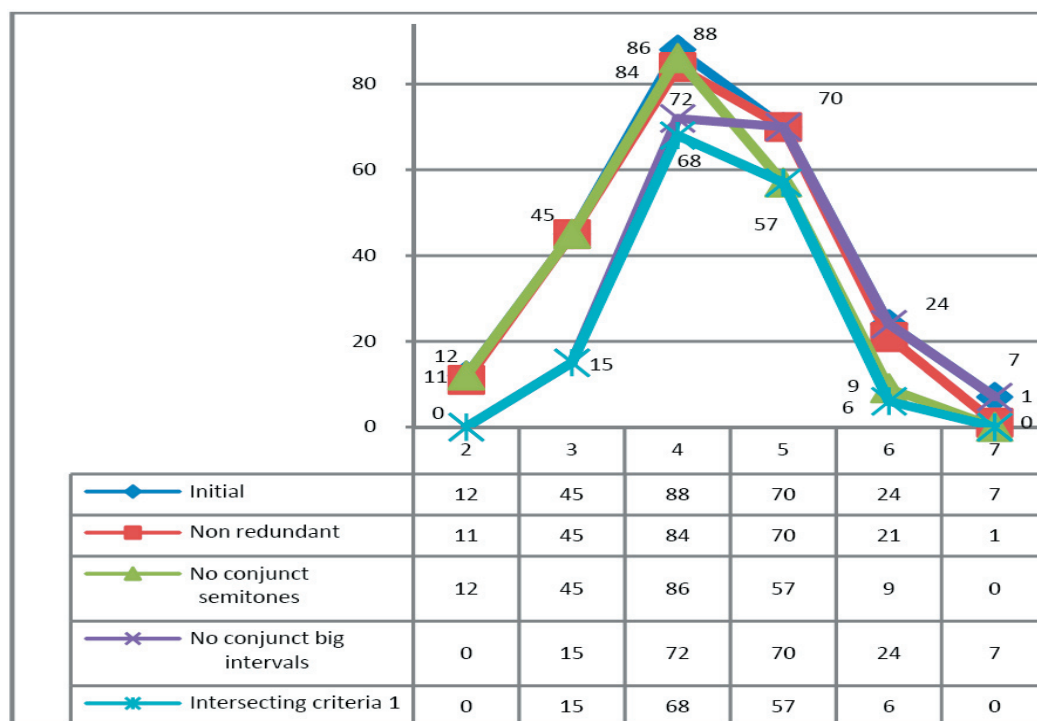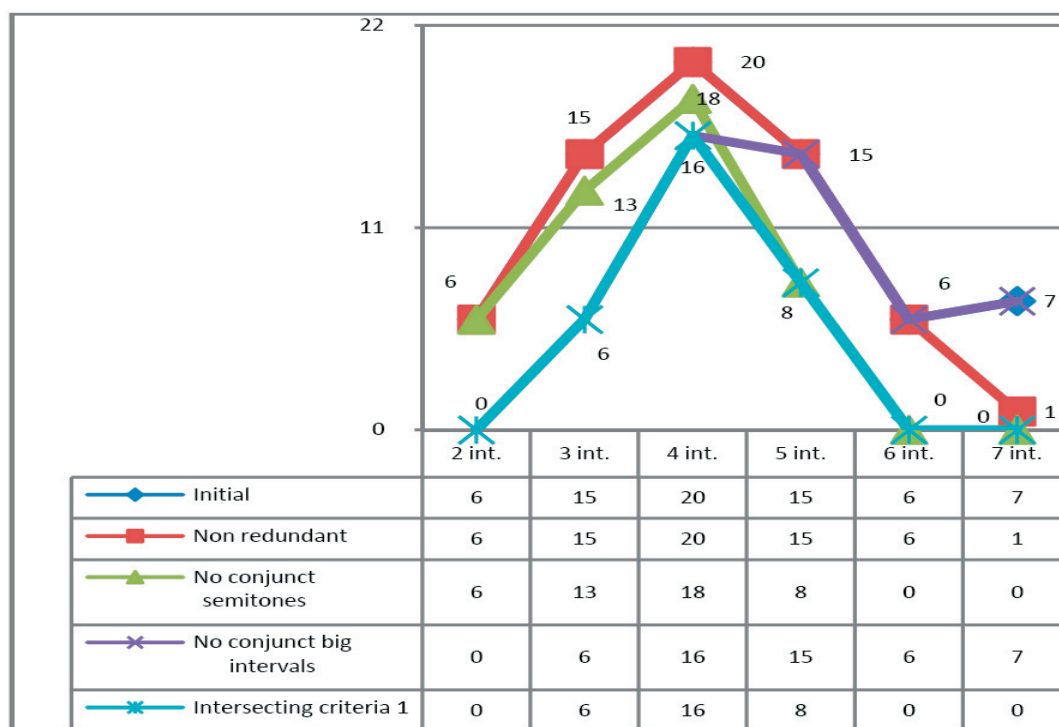|	2	3	4	5	6	7
Initial	12	45	88	70	24	7
Non redundant	11	45	84	70	21	1
No conjunct semitones	12	45	86	57	9	0
No conjunct big intervals	0	15	72	70	24	7
Intersecting criteria 1	0	15	68	57	6	0

Fig. 33. Graphs for the semi-tone (above) and quarter-tone (below) of the fifth, with the unlimited alphabet: the optimal generations are at NI=4 in both cases, but in a clearly shaped form for the first (with intersecting criteria), whenever the quarter-tone model's optimal value at NI=4 has a competition at NI=5. The no conjunct semi-tones criterion applies to suites of three or more semi-tones in a row, and the no conjunct big intervals criterion to intervals equal to or greater than 3 semi-tones.
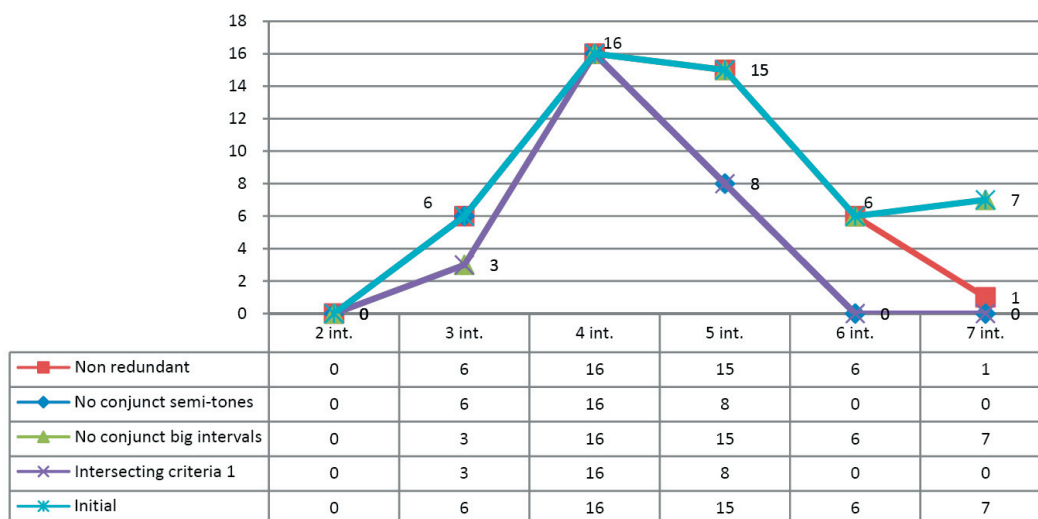
Fig. 34. Graph for the semi-tone model of the fifth with the limited alphabet 1, 2, 3: the shape of the intersecting criteria 1 line is narrower (values for NI=3 are relatively smaller than for an unlimited alphabet) and confirms the optimum for NI=4.

Remarks:

The homogeneity rule applies in all cases

Left:
- Imposed sums of 10 for last 3 int., of 14 for 4 intervals
- Imposed starting one-tone interval
- Doppled brackets underline the presence of two consecutive fourths

Right:
- Imposed starting three-quartertone interval
- All possibilities are shown - successfull combinations of the fifth have gray background, success for both fourth (between brackets) and fifth figures on black background

4244 = scalar element in just fourth AND fifth

→ **5** = successful transition interval

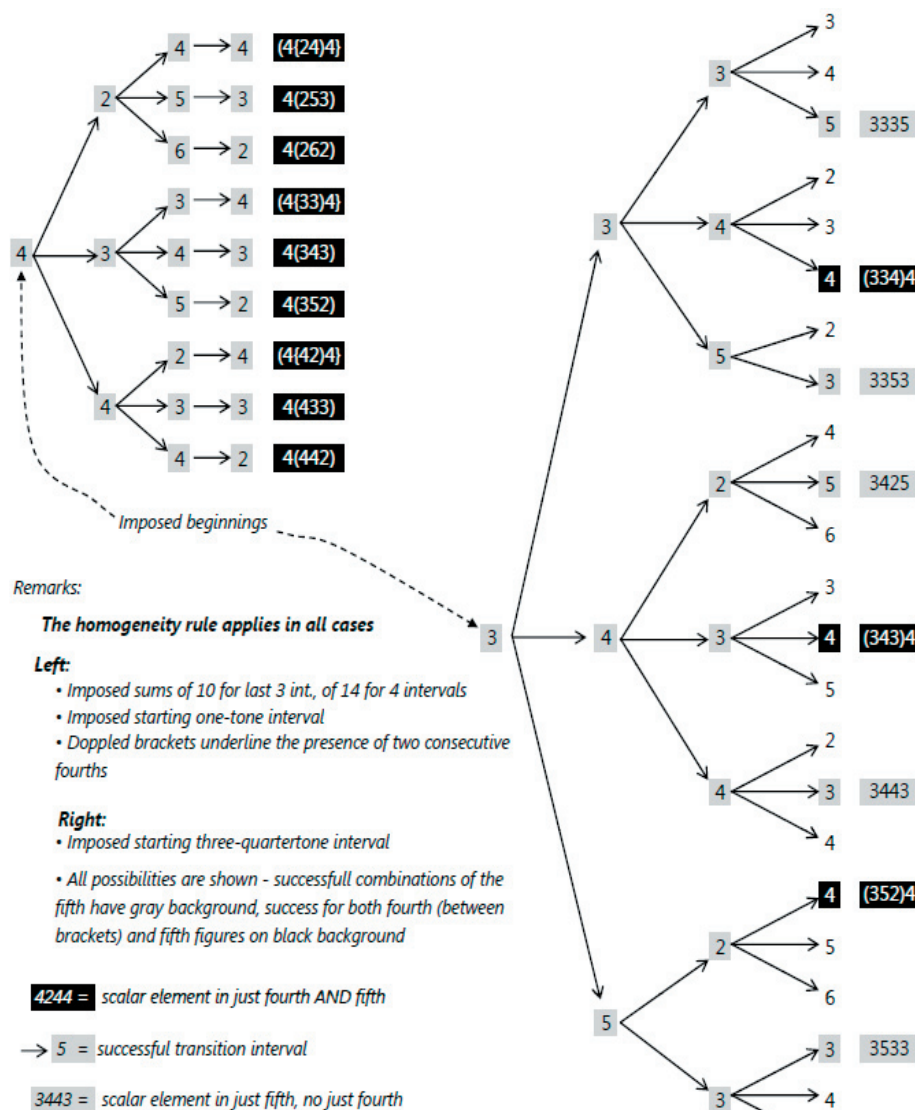**3443** = scalar element in just fifth, no just fourth

Fig. 35. Modelling the fifth with the one-tone interval initial condition and the homogeneity rule (left). Beginning with a one-tone interval increases the number of regular (and diatonic) fourths and fifths, as well as bi-fourth combinations within the fifth. Starting with a neutral interval such as the three-quarter-tones (right) lessens the possibilities for a fourth/fifth combination, as well as for bi-fourth configurations.

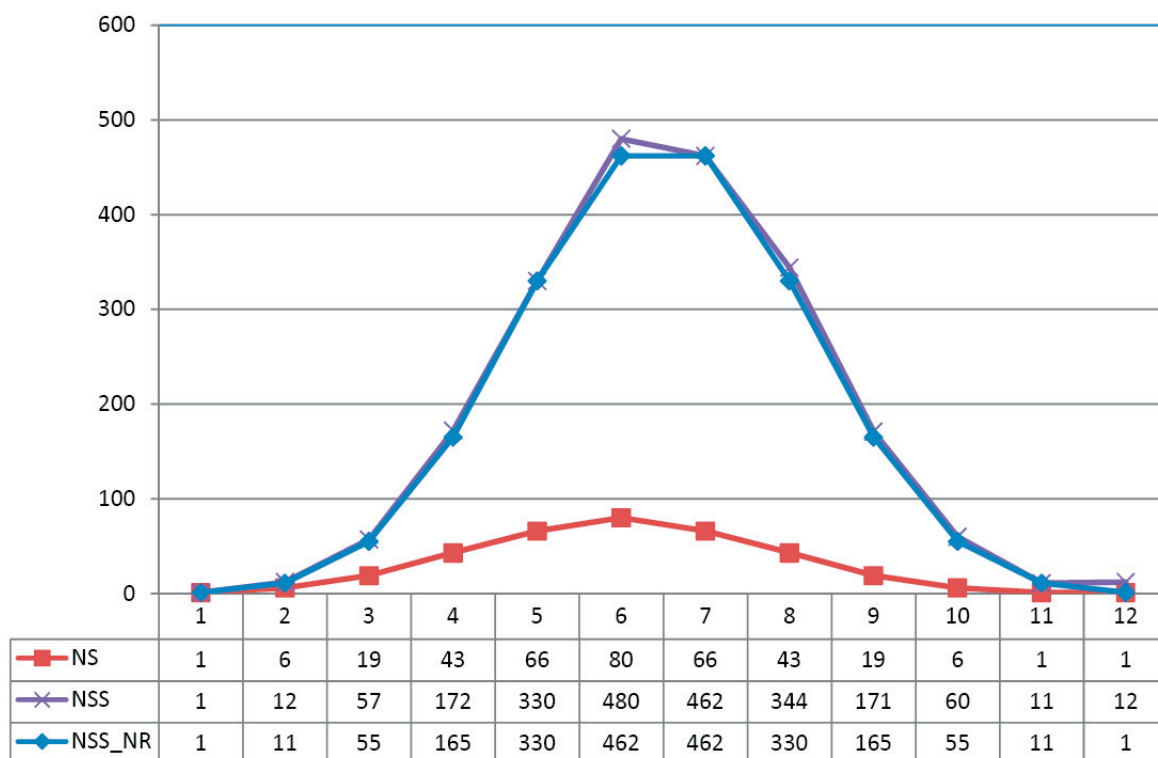|	1	2	3	4	5	6	7	8	9	10	11	12
NS	1	6	19	43	66	80	66	43	19	6	1	1
NSS	1	12	57	172	330	480	462	344	171	60	11	12
NSS_NR	1	11	55	165	330	462	462	330	165	55	11	1

Fig. 36. Systems and sub-systems in an octave, from the initial generation and filtered for redundancies (NS = number of systems; NSS = number of sub-systems; NSS_NR = NSS with redundant sub-systems excluded) - semi-tone model. Full alphabet.

	1	2	3	4	5	6	7	8	9	10	11	12
NS	0	0	0	1	6	26	38	35	18	6	1	1
NSS	0	0	1	4	30	156	266	280	162	60	11	12
NSS_NR	0	0	0	0	30	141	266	266	156	55	11	1
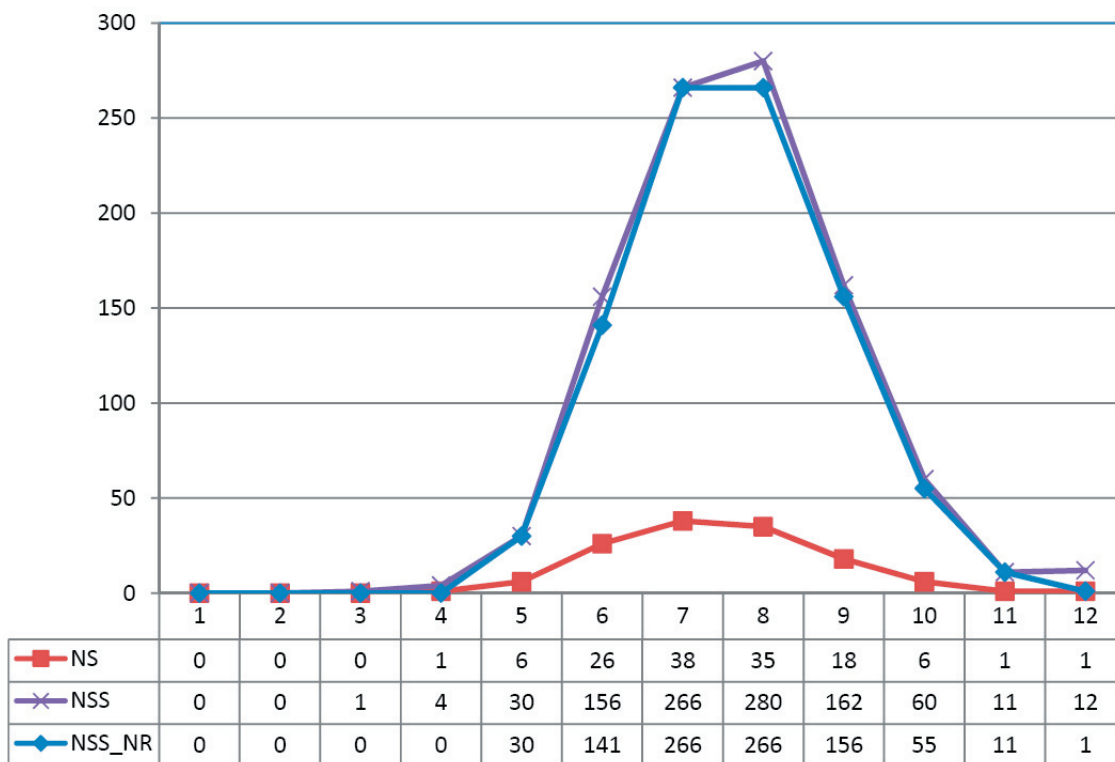
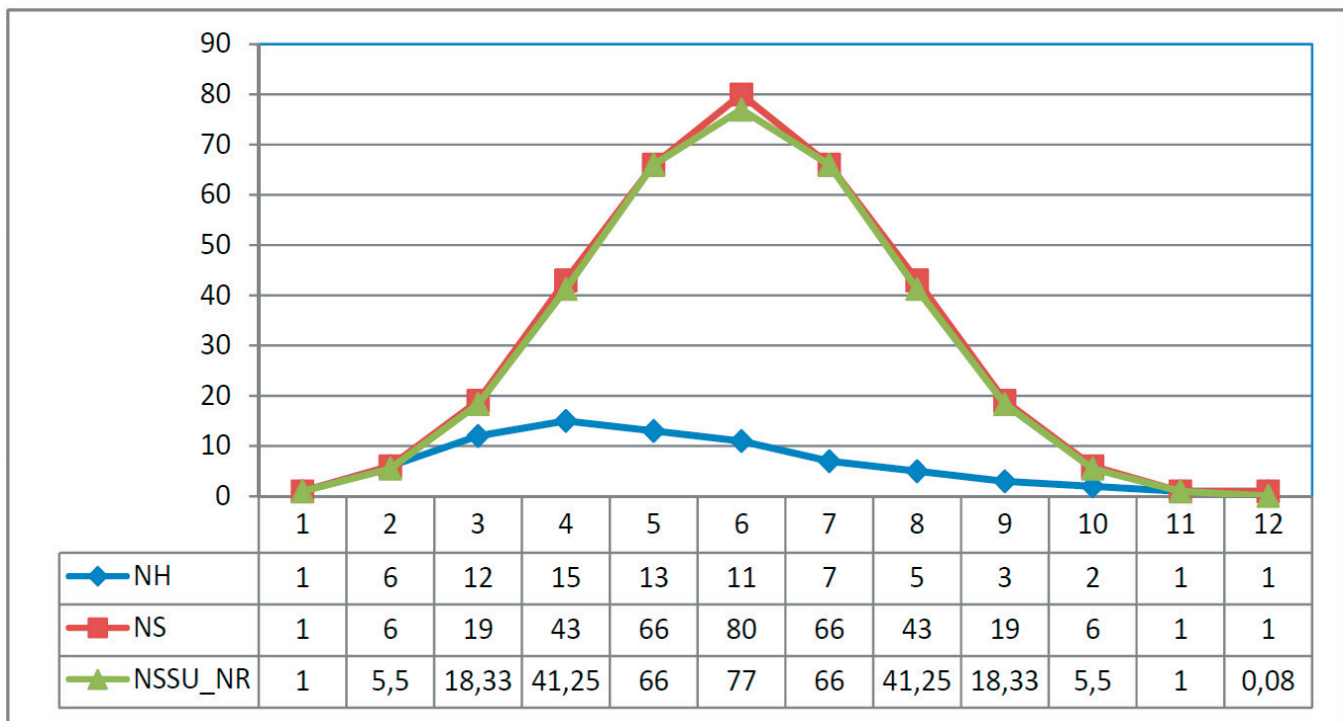Fig. 37. Systems and sub-systems in an octave: restricted alphabet (1, 2 and 3 semi-tones only).

Fig.38. Hyper-systems and systems in an octave: unrestricted alphabet in multiples of the semi-tone (alphabet = 1 to 12); NH = Number of Hyper-systems (for each NI), NS=Number of Systems, NSSU_NR is the Number of Sub-Systems in Unitary weigthing with the Redundant sub-systems excluded (NR=non-redundant).
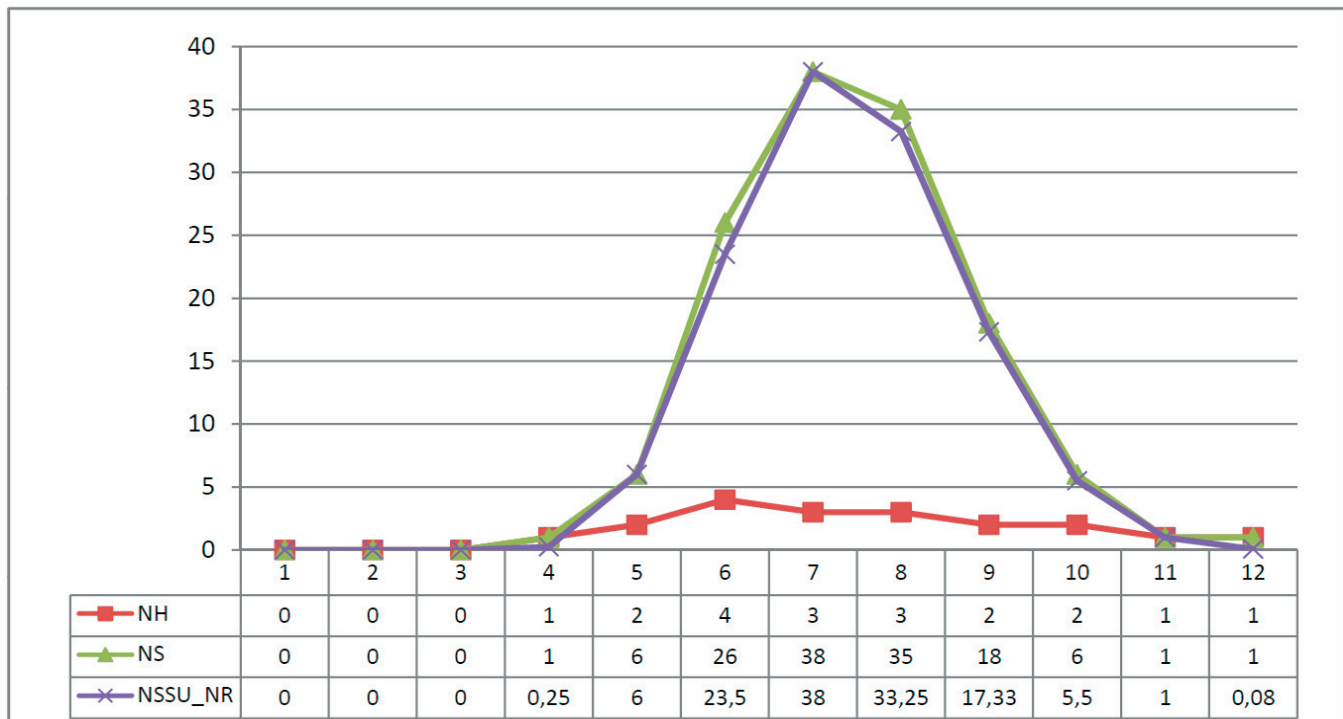
	1	2	3	4	5	6	7	8	9	10	11	12
NH	1	6	12	15	13	11	7	5	3	2	1	1
NS	1	6	19	43	66	80	66	43	19	6	1	1
NSSU_NR	1	5,5	18,33	41,25	66	77	66	41,25	18,33	5,5	1	0,08

	1	2	3	4	5	6	7	8	9	10	11	12
NH	0	0	0	1	2	4	3	3	2	2	1	1
NS	0	0	0	1	6	26	38	35	18	6	1	1
NSSU_NR	0	0	0	0,25	6	23,5	38	33,25	17,33	5,5	1	0,08

Fig. 39. Hyper-systems and systems in an octave: restricted alphabet in semi-tones (alphabet = '1, 2, 3').
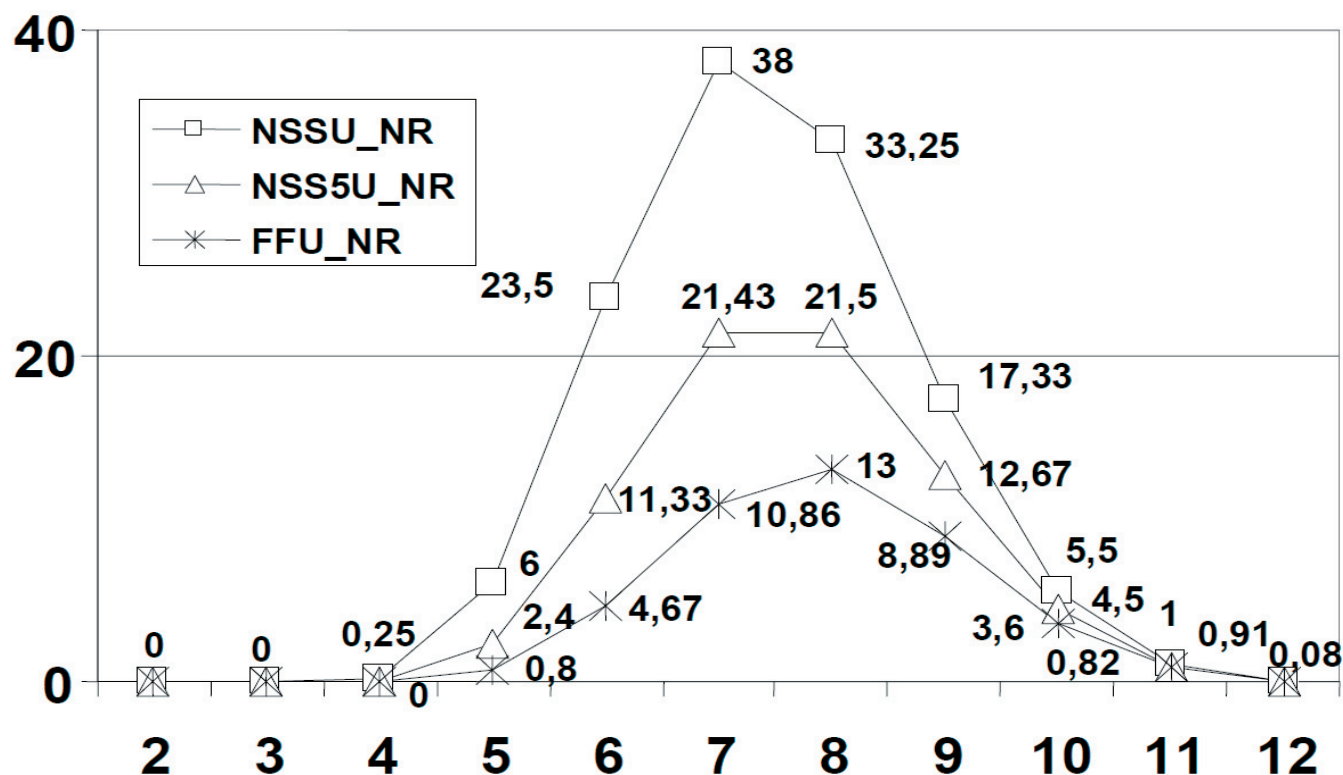
Fig. 40. Unitary non-redundant sub-systems in an octave, restricted alphabet (alphabet = 1, 2, 3) – semi-tone model: NSSU_NR is the Number of Sub-Systems in Unitary weighting with the redundant sub-systems excluded (NR=non-redundan). NSS5U_NR is the Unitary number of Non-Redundant Sub-Systems with a direct fifth (or fourth). FFU_NR sub-systems include a direct fourth in a fifth. See Appendix E, figure A1 for the full alphabet generation.
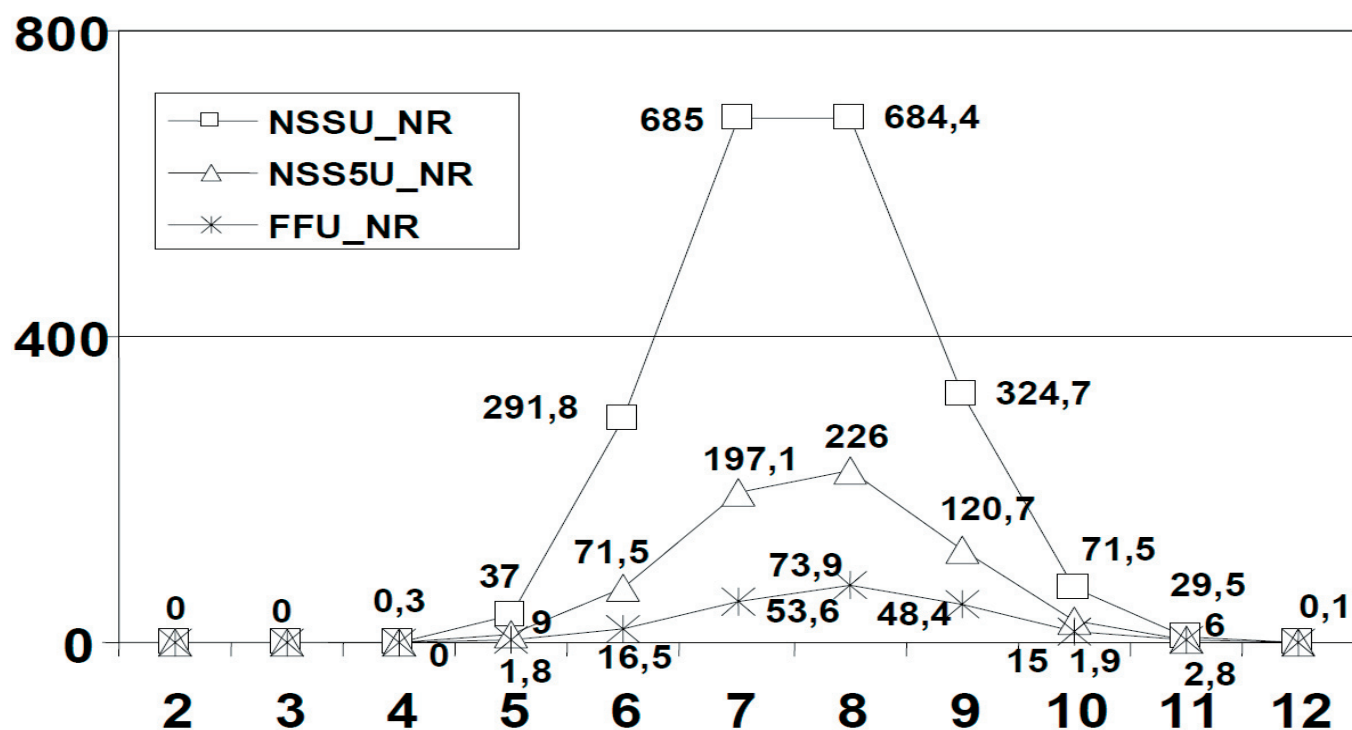

Figure 41. Same as above, but for the quarter-tone model (alphabet =2, 3, 4, 5, 6 quarter-tones) – see Appendix E, figure A5 for the (nearly) full alphabet generation.
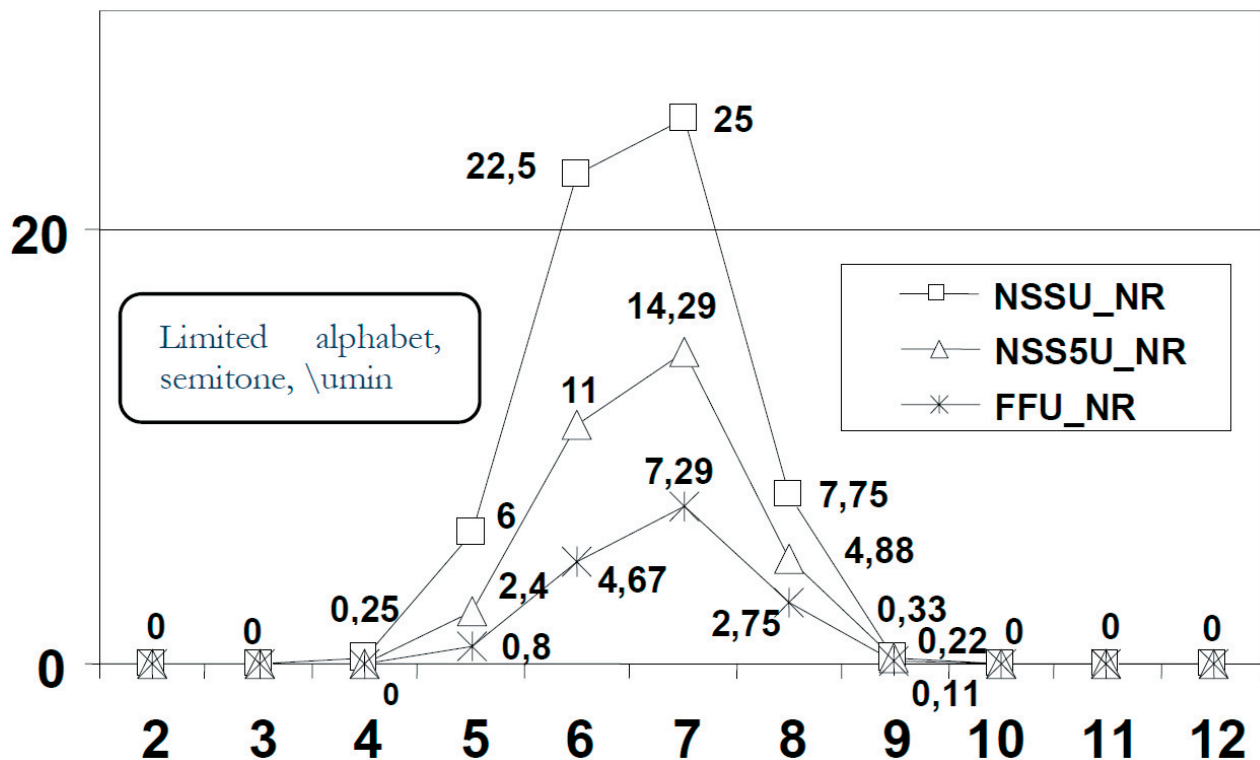
Fig. 42. Unitary non-redundant sub-systems in an octave, restricted alphabet – semi-tonal model with sub-systems containing tri-interval (or more) suites of semi-tones excluded. NSSU_NR = Number of Sub-Systems in Unitary weighting with the Non-redundant subsystems excluded, NSS5U_NR = unitary number of redundant sub-systems with a direct fifth, and FFU_NR with a direct fourth in afifth – see Appendix E, figure A3 for the full alphabet generationf
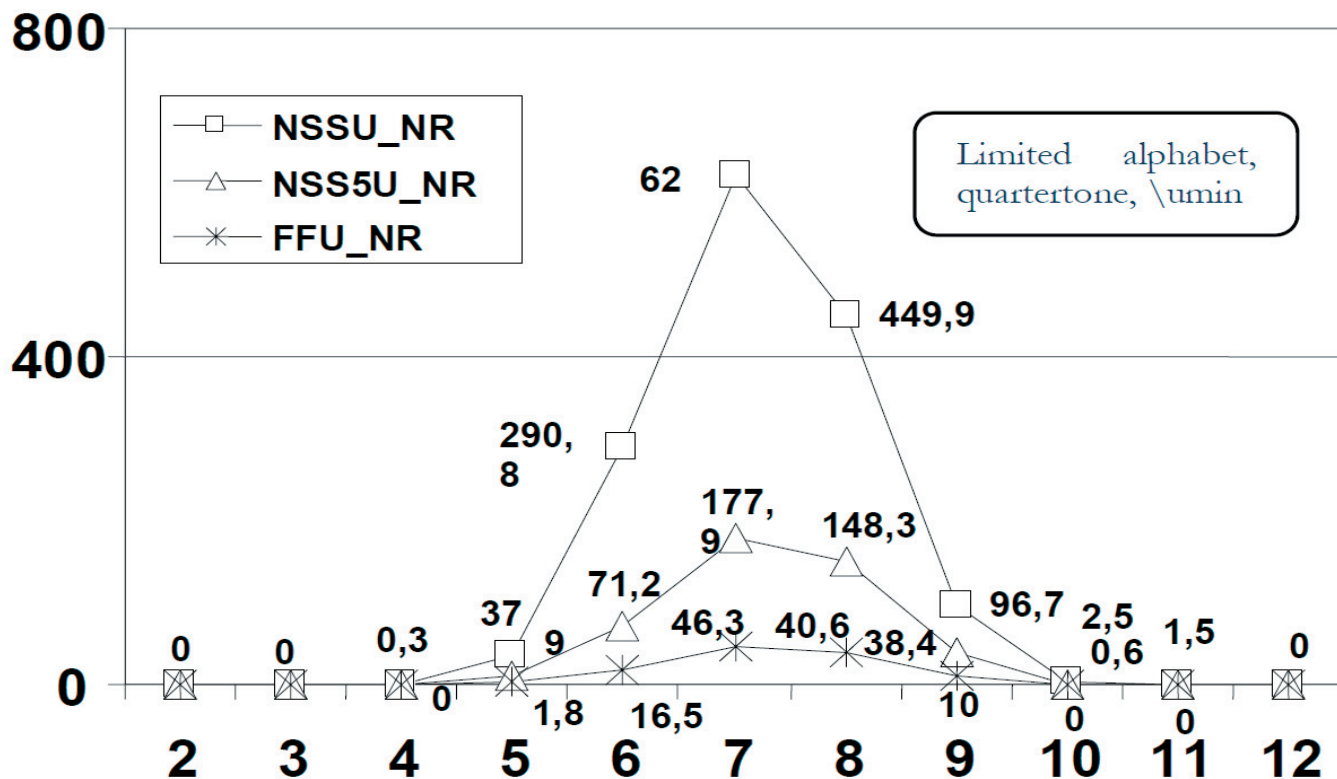

Fig. 43. Same as above, but for the quarter-tone model (alphabet = 2, 3, 4, 5, 6 quarter-tones) – see Appendix E, figure A7 for the full alphabet generation.
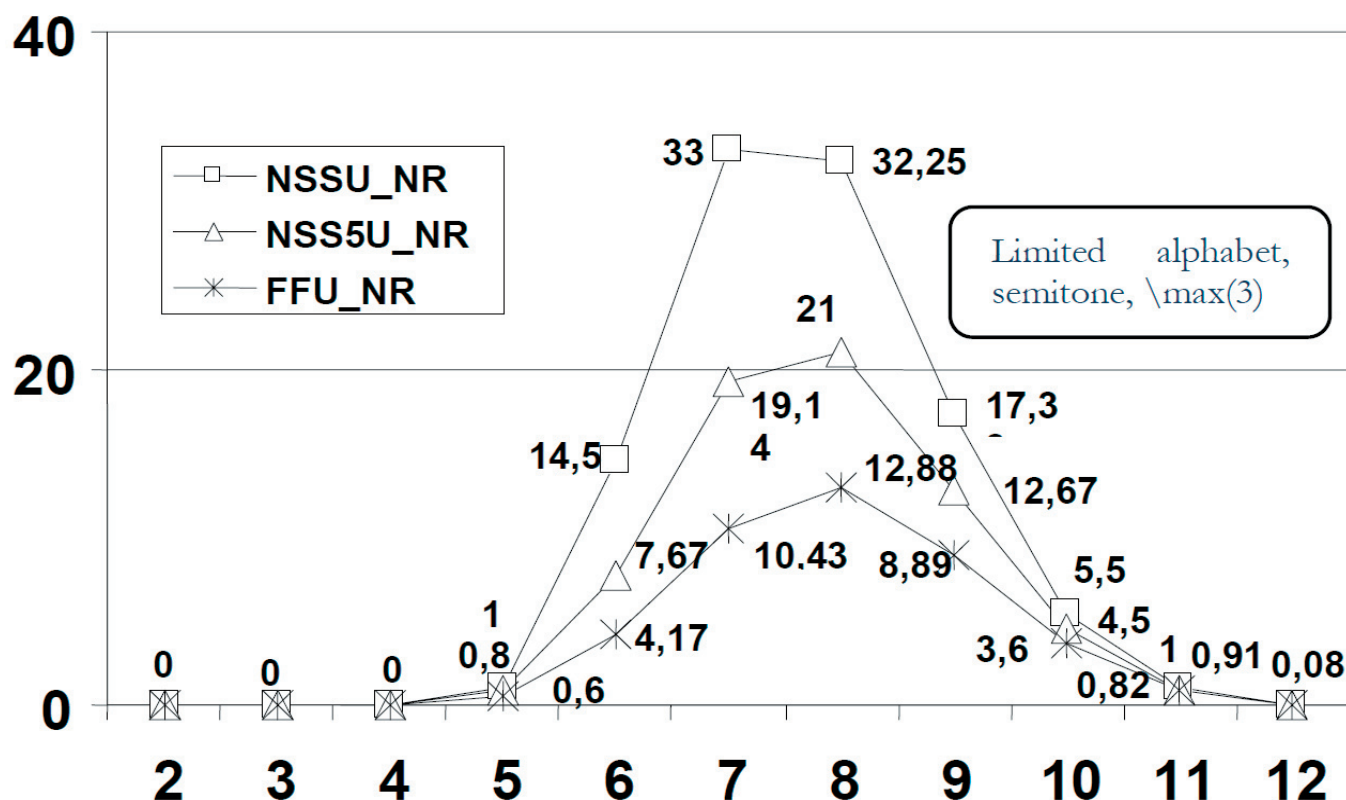
Fig. 44. Unitary non-redundant sub-systems in an octave, restricted alphabet (alphabet = 1, 2, 3) and filtering of sub-systems with bi-interval enti-ties containing two conjunct intervals greater or equal to 3 semi-tones – semi-tone model. NSSU_NR is the Number of Sub-Systems in Unitary weighting with the redundant sub-systems excluded, NSS5U_NR is the unitary number of non-redundant sub-systems with a direct fifth, and FFU_NR with a direct fourth in a fifth – see Appendix E, figure A2 for the generation with the full alphabet.
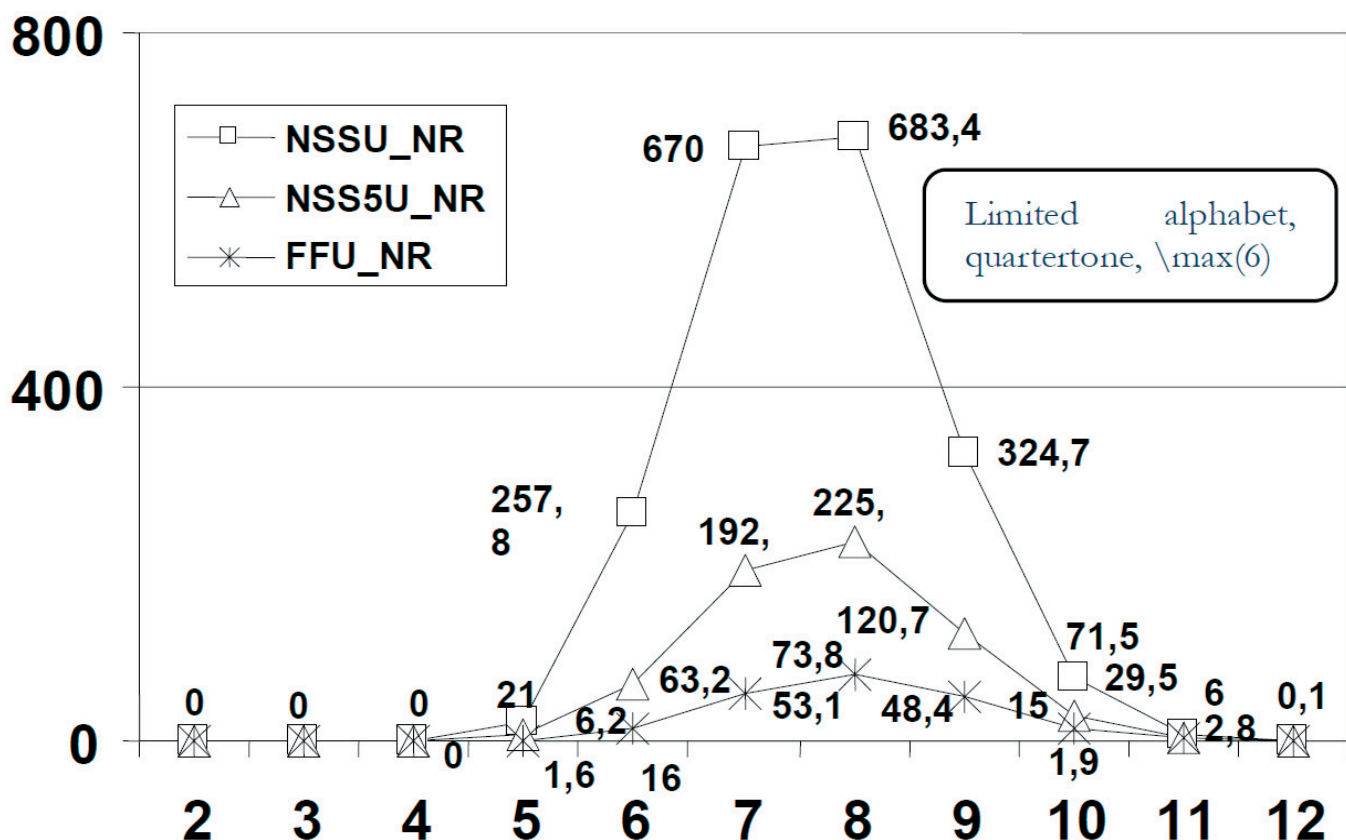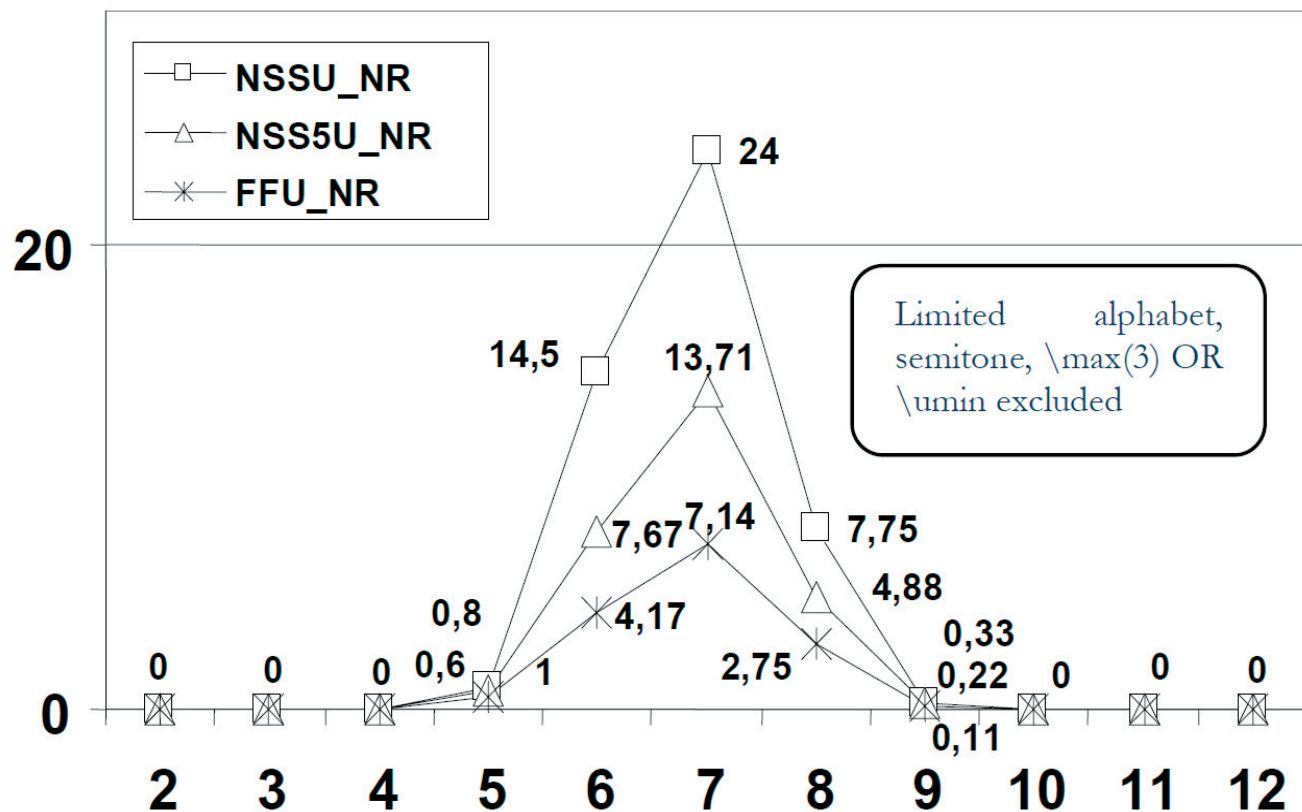

Fig. 45. Unitary non-redundant sub-systems in an octave, restricted alphabet (alphabet = 1, 2, 3) – semi-tone model with intersecting criteria (\umin OR \max(3) are excluded):[1] for variables, see previous captions.[156]

Fig. 46. Unitary non-redundant sub-systems in an octave, restricted alphabet (alphabet = 1, 2, 3) – semi-tone model with intersecting criteria (\umin OR \max(3) are excluded) for variables: see previous captions (see Appendix E, figure A4 for the full alphabet generation).
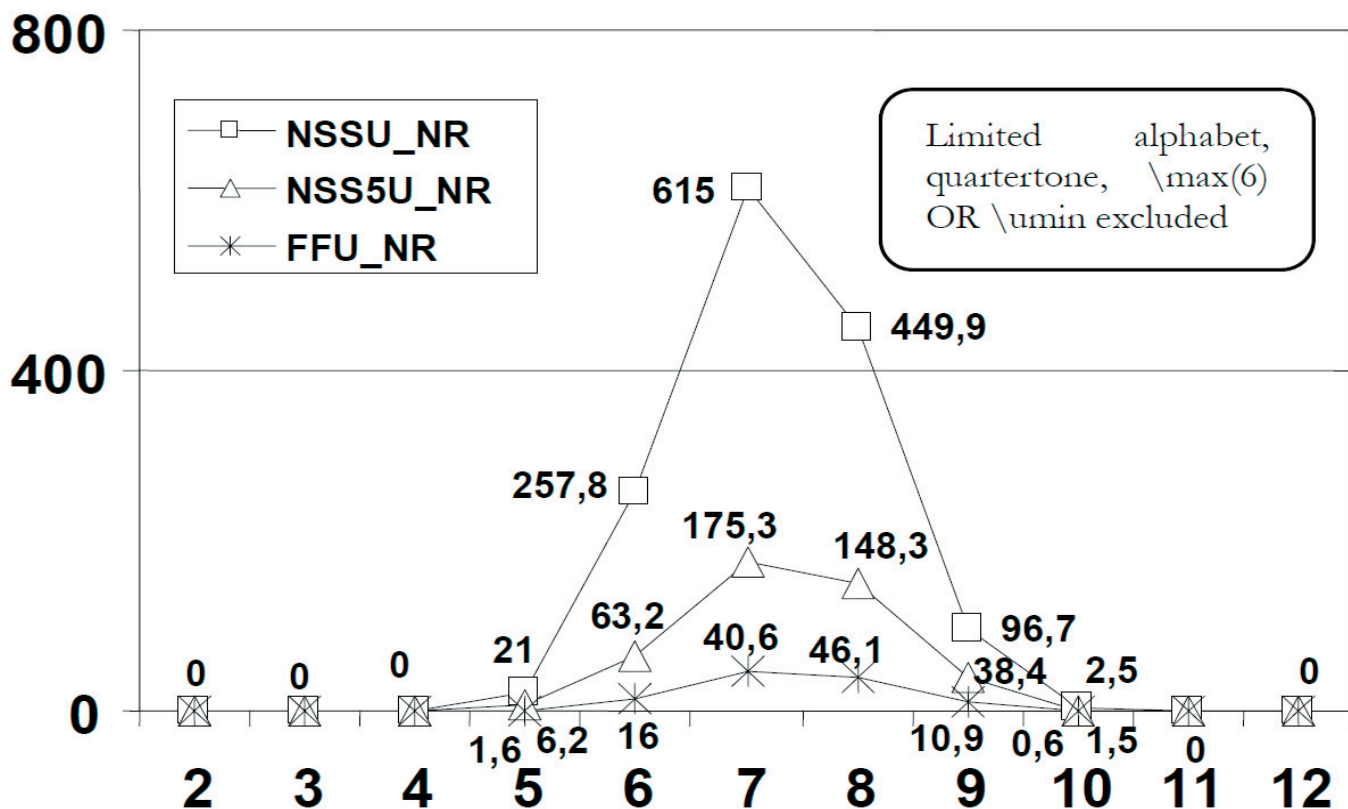

Fig. 47. Same as above, but for the quarter-tone model (alphabet = 2, 3, 4, 5, 6 quarter-tones) – see Appendix E, figure A8 for the full alphabet generation.

Notes

1 In Arabic: *Sīnā (Ibn), [Kitāb] a-sh-Shifā' - Riyādiyyāt 3 - Jawāmi` `Ilm al-Mūsīqā,* text collated by *Zakariyyā Yūsūf* and revised by *Aḥmad Fu'ād al-Ihwānī* and *Maḥmūd Aḥmad al-Ḥifnī* from some ten manuscripts, *Wizārat a-t-Tarbiya wa-t-Ta`līm,* Cairo, *Al-Maṭba`a al-Amīriyya* [end of 10th, early 11th century AD], (1956), pp. 40-4; and in French: *Sīnā (Ibn), Kitāb a-sh-Shifā'* (Mathematics, Chapter XII, Music), translated by Rodolphe d'Erlanger in *La musique arabe,* Tome II, Paris, (1936), Librairie orientaliste Paul Geuthner, p. 138. Erlanger worked from a copy of MS. 476 of the India Office, London, fols.152-74, dating from the end of 10th, early 11th century AD.

2 Beyhom, A., *Systématique modale,* 2003, unpublished doctoral thesis defended at the Université Sorbonne - Paris IV. The thesis and other publications from the present writer can be downloaded from http://www.beyhom.com/systematique/pages/excerpts_en.htm.

3 Appendices in the second part of the paper can be downloaded from http://www.iconea.org.

4 Numbers 3, 4, 5, and 7, may play a role in the outcome of interval combinations, as shown in Part II of this paper.

5 Crocker, R.L., 1963, Pythagorean Mathematics and Music, *The Journal of Aesthetics and Art Criticism,* Vol. 22, No. 2 (Winter, 1963), pp. 189-98, and No. 3 (Spring 1964), pp. 325-35.

6 We use the term 'Arabian music' as a generic concept applying to *maqām* practice, although Farmer, writes that the use of 'Arab' is well attested, in his 'Greek theorists of Music in Arabic Translation', *Isis,* Vol. 13, N°2 (1930), pp. 325-33. In note N°1, p. 325, he writes: 'I use the term "Arab" advisedly, just as I would use the word "English", at the same time implying the Scots, Irish, & Welsh. "Islamic" or "Muslim" will not serve, because Magians, Jews & Christians, contributed to this "Arabian culture." We shall include in this wide definition Turk and Persian music, as well as other *maqām* music with, mainly, heptatonic scales – and 'neutral' (this term is defined below) intervals used in the latter.

7 Additionally, the Pythagorean cycle of fifths does not generate a fourth. The scale is the consequence of an ascending cycle of fifths, bringing notes placed above the first octave back into it, hence F G A B c d e. The fourth, ascending from starting F, is F-B which is a Pythagorean tritone.

8 Aristoxenus, *Elements of Harmonics,* translated and commented by Macran, H.S., *Aristoxenou Harmonika Stoicheia: The Harmonics of Aristoxenus,* (Oxford, 1902), pp. 193-8, notably (pp. 193-4) '*For the apprehension of music depends on these two faculties, sense-perception and memory,*' or p. 197: '*That no instrument is self-tuned, and that the harmonizing of it is the prerogative of the sense perception is obvious.*'

9 Superparticular intervals with string ratios of the type $(n+1)/n$ when n is a positive integer.

10 See Chailley, J., *Éléments de philologie musicale,* (Paris, 1985), pp. 64-5.

11 Acoustic resonance is not a generative process as such, but it is the consequence of the physical (and dimensional) properties of matter set to vibration. The integration of acoustic resonance within a generative theory is subjective as it admits that vertical relationships cannot be unidirectional, *i.e.,* ascending.

12 A computer program has been used to test this hypothesis, up to the 1500th harmonic, and gave no exact matches for the just fourth. A first approximation is found at the 341st harmonic, with about 496 cents, then 499 cents with the 683rd harmonic. The closest is the 1365th harmonic with 498 cents. The calculations were based on the formula: $i = 1200 \times \ln(R) / \ln(2)$, where 'i' is the interval in cents, 'R' the ratio of frequencies (the ratios of frequencies are 341, 683 and 1365, respectively), and then extracting modulo of (i/1200). In analytical terms, the problem consists in finding an integer J, which multiplies N, the frequency of the fundamental tone, and the ratio of which, to the nearest and lower octave (octaves of the sound with frequency N have the form $2^k N$, where k is an integer number) is equal to 4:3, or $[(J \times N)/(2^k \times N) = (4/3)]$ (k is the power indicator of 2, with $2^k \times N$ being simply an even multiple of N), which is not possible

because in this case $[J = (2^k \times 4)/3]$, and neither 4 nor a power of 2 (2^k) can divide 3.

13 Helmholtz, H., *On the sensations of tone as a physiological basis for the theory of music,* (ed. Ellis, A.), (London 1895), pp. 192-4 (figs 60 A and 60 B, p. 193). The consonance of the fourth is explained in that two simultaneous notes at a fourth apart have some theoretical harmonics in common, as for example for two notes at (1) 300Hz and (2) at 400Hz, which have common harmonics with frequencies equal to 1200, 2400, 3600Hz (etc.), *i.e.,* for every common multiple of 300 and 400.

14 In order to assemble a very approximative octave made up of the degrees of the diatonic scale, various resonance theories generally end up at the fifteenth harmonic, which is a 'b' if the fundamental is 'c' or, 'e' if the fundamental is an 'f'. This is an arbitrary proposition since no reason is given for having chosen the fifteenth harmonic as a last pitch and also this would require extraordinary hearing powers, since this fifteenth harmonic placed right below the fourth octave has generally little intensity. Therefore preceding pitches from the 7th, 11th and 14th harmonics, theoretically, should be heard much louder than the 15th harmonic.

15 This process is plainly explained in Barbera, A., 'Octave species', *The Journal of Musicology,* Vol. 3, N°3 (Summer, 1984), pp. 229-41, especially pp. 231-2: 'Aristoxenus has described the enharmonic genus in such a way that there can exist only three species of fourth. This is so because he has allowed only two different intervals, the enharmonic diesis or quarter-tone and the ditone, to enter his discussion. Thus we can arrange two quarter-tones and one ditone in at most three different ways. Had Aristoxenus considered a chromatic genus containing three different intervals, for example, 1/3 tone, 2/3 tone, and 1 ½ tones, what would have been the result? Later writers make clear that the six possible arrangements of these three intervals were not all possible musically. In fact, only the first, second, and third species were musical possibilities, i.e., those species that are arrived at by making the highest interval the lowest or vice versa, leaving the rest of the sequence unchanged. The three arrangements that are not considered are neglected, I believe, because they are not species of a musical genus. A genus is, after all, a tuning, or more precisely, infinitely many tunings within firmly established boundaries. Such tunings presume a musical scale or system as background - a first note or string, a second note, third, and so forth. One can focus attention on any four consecutive notes of the scale and, depending upon the segment of the scale that is chosen, one can discern a variety of species. At no point, however, can one alter the sequence of notes of the scale. For instance, the third note of the system never becomes the second note. Therefore, because a system - the Greek musical scale - is assumed, and because species must be species of a genus, there can exist only three, not six, species of any specific tuning of a musical fourth.'

16 *Fārābī* [9th-10th century] in Erlanger, Baron R., *Kitāb al-Mūsīqī al-Kabīr,* La musique arabe, Vol.1, (Paris, 1930), p. 127: 'Should a consonant interval be repeated within a group, the small intervals could be situated at difference places in that group. Thus the fifth having been placed within a group with a certain arrangement of its small intervals, one can, within the same group have other fifths having their small intervals arranged in another way. For instance, the first interval in the first arrangement might be the last in another. In the case an interval is seen often in a group with its small intervals differently arranged, each of these arrangements of small intervals form a kind, a species, of a group. Within an interval, the arrangement of small intervals it contains can be classified as first, second, etc., until the various arrangements in this group are exhausted.'

17 Cleonides, *L'introduction harmonique,* (ed. and tr. Ruelle, Ch.), (Paris, 1884), notably §71 which says: 'Differences are produced numerically in the following manner. Having agreed that the tone is divided in twelve small parts each of which called a twelfth of a tone, all the other intervals have a proportional part in relation to the tone.'

18 *Fārābī, Kitāb al-Mūsīqī...,* pp. 59-.

19 Metrologic accuracy is essential to mathematical precision. However, *Fārābī* himself aknowledges that music performance dismisses very small intervals in the scale – see *Fārābī, Kitāb al-Mūsīqī* …, pp. 174-6.

20 '1 1 3' (semi-tone, semi-tone, one-and-a-half-tones): *Aristoxenus, Elements…*, pp. 202-3.

21 '1 2 2' (semi-tone, tone, tone): *Aristoxenus, Elements…*, p. 204.

22 These could be called species and are defined as sub-systems in Modal systematics.

23 More than two thousand years ago, Ancient Greek theory included the semi-tone equal temperament which is in use in most Western music today (classical, to some extent, and pop music in general), together with modern Arabian quarter-tone divisions of the octave. (Aristoxenus' theory is based on a quarter-tone division. He defines the fourth as composed of five semi-tones. See Macran, H., *The harmonics of Aristoxenus…*, p. 208).

24 Such as many types of unequal, temperaments.

25 *Urmawī's Book of cycles* is extensively analysed by Wright, O., in *The Modal System of Arab and Persian Music A.D.1250-1300,* (Oxford, 1978). There appears to be no translation in English. There is a translation in French by Erlanger (1938) but there he refers to a commentary of the *Sharḥ Mawlānā Mubārak Shāh bar Adwār*, which he attributed to *Ṣafiy-y-a-d-Dīn al-Urmawī*, under the title of *Kitāb al-Adwār* [Livre des cycles musicaux], in *La Musique Arabe*, Vol.3, (ed. Erlanger, R.), (Paris, 1938). In the same volume, Farmer (p. XIII of Erlanger's translation) ascribes it to `Alī ibn Muḥammad a-s-Sayyid a-sh-Sharīf al-Jurjānī.

26 The Pythagorean *comma* is the amount of six Pythagorean tones (8:9) from the sum of which one octave is taken away. The *comma* has the ratio of 524288:531441, which is about 23 cents. This discrepancy is the consequence of the Pythagorean tone, about 204 cents being slightly larger than the equal temperament tone at 200 cents. Therefore the octave is made up of five tones and two *limmata*. The fifth is made up of three tones and one *limma* (about 702 cents), and the fourth, of two tones and one *limma* (498 cents). The *limma* is the 'left over' quantity between two Pythagorean tones away from a fourth. This amounts to a ratio of 243:256, about 90 cents.

27 The *limma* is the complement of the Pythagorean ditone within the just fourth of ratio 3:4.

28 One of *Urmawi's* octave representations runs as: L L C, L L C, L, L L C, L L C, L L C, L. Placing notes at Pythagorean boundaries, we have c (L L C) d (L L C) e (L) f (L L C) g (L L C) a' (L L C) b' (L) c'. In the *maqām Rāst* of Arabian music, as defined by *Urmawī*, the boundaries stand differently: c (L L C) d (L L) e- (C L) f (L L C) g (L L C) a' (L L) b'- (C L) c'. The intervals between d and e- (or for the latter a pitch which stands between e flat and e sharp) and between e- and f are the *mujannab*, or neutral, seconds of *Urmawī*. The same applies to the intervals between a' and b'- and c'. Their value is (L+L) or (L+C), but both hold the same name of *mujannab*, whilst intervals such as the *limma* 'L' or the tone, have one single interval capacity, that is one *limma* for the semi-tone (with *Urmawī*), and two *limmata* and one *comma* for the tone.

29 The concept remains the same throughout history, and is based on the division of the tone into three small intervals and on the division of the 'neutral' second in two other, even smaller ones. See Beyhom, A., '*Arabité et modernité en musique, ou de quel modèle se démarquer*', Congrès des Musiques dans le monde de l'islam, Assilah, August 8-13 2007: http://www.mcm.asso.fr/site02/music-wislam/articles/Beyhom-2007.pdf.

30 Accuracy to the 4th decimal is needed only for computational purposes as in practice anything under two cents is hardly noticeable.

31 The tense diatonic *genus* is the Western paradigm. There are many other diatonic *genera* known from the Greeks (and the Arabs) which we shall not discuss here.

32 For example, Ṣabbāgh, T., *a-d-Dalīl al-Mūsīqī al-`Ām fī Aṭrab al-Anghām,* (Aleppo, 1950).

33 Ṣabbāgh, in his *Dalīl…* (p. 29 for example), uses the terms 'flat plus one quarter' for the note e- in the scale of the mode *Rāst*, although

the intervals that surround it are different in size (6 HC and 7 HC).

34 Conceptual intervals represent qualities of intervals when used in a melody or a scale. Compared one to another, each has a unique and identifying quality which relies on its relative size. These compose the fourth, the fifth or the octave, and play a distinct role in performance, bearing in mind fluctuations and regional preferences which will be stressed for the degree *sīkā* in Arabian music for example, (fig. 7, p. 173) and identified by the performer as a semi-tone, a *mujannab*, or a one-tone interval, and so forth. The Arabian usage of the HC agrees with the adepts of Pythagoras who insisted in the Pythagorean approximation of the Arabian scale, instead of an Equal Temperament. The reason is that the odd number of HC in one tone (nine) and its distribution among the Pythagorean *limma* (4 HC - sometimes called 'minor' semi-tone) and the Pythagorean *apotome* (5 HC - sometimes called 'major' semi-tone) are good enough approximations and represent two different intervals whenever the *mujannab* in Arabian music, conceptually equivalent to one and single interval, may also be approximated to two intervals of slightly different sizes, *i.e.*, 6 HC and 7 HC, which, when added, equate to the augmented second of the Western scales.

35 Elsewhere, b- may be used for b♭.

36 Depending on the transliteration and, or, on local pronunciations: *sīkā, segah, seh-gāh*, etc.

37 The positions of the notes in the *maqām*, including the fundamental, may vary slightly during performance. See Beyhom, A., [Une étude comparée sur les intervalles des musiques orientales], *Actes du colloque Maqâm et création (Fondation Royaumont, October 2005)*, p. 18-24,: http://www.royaumont.com/fondation_abbaye/ fileadmin/ user_upload/dossier_PDF/programmes_musicaux/ COLLOQUE_ MAQAM_ET_CREATION_OCTOBRE_2005. pdf, and Beyhom, A., 'Dossier: Mesures d'intervalles - méthodologie et pratique', *Revue des Traditions Musicales des Mondes Arabe et Méditerranéen* (*RTMMAM* N°1), (Baabda-Lebanon, 2007), pp. 181-235.

38 This and the following explanations are based on the author's own experience while practicing Lebanese folk tunes, as well as on interval measurements of performance examples in various modes including the degree *sīkā*; on thorough discussions with teachers of Arabian music (mainly on the `ūd), and also on an extensive and systematical study of contemporary *maqām* theory in the Near and Middle-East. For the latter see Beyhom, A., *Systématique...*

39 The mode *Sīkā* traditionally begins with the note *sīkā*.

40 The two are commonly used both with Classical and Folk Arabian music in the Near-East.

41 Signell, Makam, K., *Modal Practice in Turkish Art Music,* (Nokomis-Florida, 2004). Turkish modern theory uses the HC approximation for its intervals. In practice, however, as Signell stresses (pp. 37-47) and the way in which many contemporary Turkish musicians perform (as underlined for Kudsi Erguner on *Nāy* or for Fikret Karakaya on Kemençe in Beyhom, A., *Étude comparée…*), the note *sīkā* tends to be played lower than its assigned value (that is e minus one *comma* in Turkish theory), notably in *maqām Rāst, Ṣabā* and *Bayāt*.

42 The difference between the mobile notes of Ancient Greek theory and the variable position of the single note *sīkā* lies in the fact that mobile notes may move from one position to another in the general scale, whilst the variability of the degree *sīkā*, for example, involves only one position in the general scale, which varies. An example of mobility is a change from pitch e to pitch e♭ for example,when a minor tetrachord d e f g modulates into a Kurdish tetrachord (or also as the introductory tetrachord in the flamenco scale, starting with 'd': d e♭ f g), while the position of *sīkā* may vary depending on a certain number of factors, but its relative positioning in the scale remains the same (it is still considered as the same intermediate pitch between e♭ and e, or e-).

43 For example the *sīkā* in Lebanese Folk music is lower than the *sīkā* in…

44 The urge for such a concept is even more evident with music not responding, partially or completely, to temperament, such as we have with traditional a capella singing worldwide.

45 At least in *Urmawī's* concept of the scale: it is much later in the history of music theory that some theoreticians began using the Holderian comma as a measuring interval for approximating Pythagorean intervals, but this can not apply to theorteticians of the Middle Ages who dealt mainly, if not exclusively, with Pythagorean interval (or string) ratios for interval handling.

46 This means that a melody would not, in the modal or *maqām* music described in *Urmawī's* theories, move directly from one pitch to another, one *comma* apart, unless this process is used in performance as an intonation variation within the original melody (in which case the size of the *comma* is very approximate). This is still the case with Arabian music, but where the quarter-tone is the elementary interval of the 24-ET - see the example of *maqām Awj Āra* in Part II and note 90.

47 The explanation of the role of two consecutive *mujannab* lies possibly in the perception of this interval as being the result of the division of the one-and-a-half-tones interval in two smaller intervals. More information about this process can be found in Beyhom, A., *Approche systématique de la musique arabe: genres et degrés système, De la théorie à l'art de l'improvisation* (ed. Ayari, M.), (Paris, 2005), pp 65-114, in which case, any two *mujannab* in a row must add up, at least in theory, to the greater tone shown in figure 8, *i.e.*, composed of 3 *limmata* and one *comma*: the only possibility for this is that the two *mujannab* be of different sizes.

48 Because three small intervals are necessarily bigger than a *mujannab*, which means that their sum must necessarily be equal to the one-tone Pythagorean interval, which stands next in the row of conceptual intervals.

49 One could also use the corresponding letters, for example S, M, T, etc., for the combination process: numbers have the same discriminating power, but have the advantage of allowing a quick check of the sum of the elementary intervals in the series.

50 This simple algorithm is used for computer combination process and is very efficient for larger interval series as, for example, a heptatonic scale: it is applied in a more elaborate formulation in the generative procedures used by the Modal systematics theory, which allow a complete survey of hyper-systems, systems and sub-systems as they shall be defined below.

51 Aristoxenus, *Elements...*, Barbera, A., *Octave species...*, aforementioned.

52 The additional *genera* of *Fārābī* are what I call the neutral tones genus (which is equivalent to the Arab *Bayāt*), and the original equal tones tetrachord: expressed in multiples of quarter-tones, the first *genus* can be represented by 3 3 4, or three-quarter-tones, three-quarter-tones, and one one-tone, intervals. In its essence, it is equivalent to the equal diatonic *genus* of Ptolemy with successive string ratios of 11/12, 10/11 and 9/10. For a general survey of Greek genera, see Barbera, A., Arithmetic and Geometric Divisions of the Tetrachord, *Journal of Music Theory*, Vol.21, N°2, (Yale, 1977), p. 294-323, notably pp. 296, 298, 302, 303, 307, and Mathiesen, Th., *Appolo's Lyre*, University of Nebraska, 1999, pp. 468-75. The second addition of *Fārābī*, the equal-division *genus* (or equal-tone division of the *genus*), is composed of three identical intervals each of which has a size of 5/6 tone (see *Fārābī, Kitāb al-Mūsīqī…*, pp. 58-9).

53 The total number of combinations is obtained through the formula N!, in which N is the number of intervals to combine. Here, we have 3! (or three factorial) which is equal to 3 x 2 x 1=6. On the other hand, any rotation of three identical intervals would give the same redundant combination, like in a a a, for example.

54 This process is used in statistical and probability algorithmic, which is historically a recent domain in science.

55 And for music theory as a whole.

56 This process is called the Wheel by Byzantine chant theoreticians. It is applied to intervals composing a fifth repeated in a row. See Giannelos, D., *La musique byzantine*, (Paris, 1996), p. 89, 'Le système de la roue'.

57 Which are named sub-systems in the Modal systematics theory.

58 Together as the first sub-system of the series.

59 There are other more sophisticated algorithms for interval combinations in computer mathematics but our main purpose is to remain as close as possible to an intuitive handling of intervals.

60 The hyper-systems, systems and sub-systems are, in the general case of statistical research on scales (in Modal systematics), generated with the help of a computer program based on an extended version of the algorithm shown in figure 9, p. 174.

61 Or one semi-tone, one tone and a half, one semi-tone: this tetrachord is equivalent to the tonic chromatic tetrachord of Aristoxenus, with the semi-tones placed on both sides of the one-and-a-half-tones interval.

62 This mode is also frequently used in gypsy music, and also with film music, notably the score by Maurice Jarre for Lawrence of Arabia (dir. David Lean, 1962).

63 This is the most homogeneous system among the three, with only two different classes of intervals used.

64 In the case of the latter music, scales are notated differently but are conceived as being the same as Arabian corresponding scales. This is too lengthy a subject to be treated here, but the reader can have more information in Beyhom, A., *Étude comparée…*

65 The question arising here is why, out of this great number of potential scales, traditional music around the world would use only a few? A first answer to this question was given in Beyhom, A., *Systématique modale..*, in which some of the criteria suitable to scale system in order to verify if they correspond to musical practice as we know it are identified, such as the presence of a fourth or fifth from the tonic, and/or the absence of particular scale combinations (such as combining two large intervals in a row, or more than two semi-tones in a row, etc.). Applying these conditions, as well as others, to the scales of the quarter-tone generation which can be made up, we can get close enough to the configuration of scales used today, particularly in Arabian music. Exceptions can be dealt with separately, and will give valuable information about this particular music, and, of others, and the additional criteria applying to it.

66 There is a relatively simple empirical formula for the calculation of the number of systems which can be generated by a hyper-system provided that the total Number of Intervals in one hyper-system is NI intervals, and that different classes of intervals contained in the hyper-system have a capacity Oi (each interval i is reproduced Oi times in the hyper-system), the number of distinct permutations of intervals within the hyper-system is equal to (NI!)/(O1! x O2! x O3! etc.). In the case of hyper-system N°12, interval 2 occurs five times, and interval 4 twice, by replacing in the formula we obtain the number of distinct sub-systems or [(7!)/(5! x 2!)] = [5040/(120 x 2)] = 21. The structure of the formula explains why homogeneity of the conceptual intervals composing a hyper-system, is a factor that lessens the number of resulting (non-redundant) sub-systems.

67 Some of the scales found in the literature are questionable: a review of Arabian scales is given in Beyhom, A., *Systématique modale…* (see for example Vol. III, pp. 15-50).

68 This is discussed in Beyhom, A., Des critères d'authenticité dans les musiques métissées et de leur validation: exemple de la musique arabe, *filigrane*, 5, (Paris, 2007), pp. 63-91.

69 And reciprocally.

70 Recent research was commented on at the *Congrès des Musiques dans le monde de l'islam in Assilah – Morocco*, in 2007. This showed a continuity of the 17 unequal intervals per octave model (or seven intervals in a just fourth and three in a one-tone interval), throughout the history of Arabian theory, beginning with *Kindī* (9th century). The 17-ET model is a simplification of the 17 unequal intervals scheme(s) and is conceptually equivalent to the latter. This applies equally to the 24-ET model used in the statistical study in Part II of this article with a limitation of the smallest conceptual interval to the semi-tone.

71 The internal structure of the fourth or of the fifth may differ within the 17 intervals to an octave model and the quarter-tone model, when considering possibilities other than the three intervals to the

fourth and four intervals to the fifth. Furthermore the 17th of octave model allows a differentiation between the chromatic *genera*, based on hyper-system 1 2 4 in the 17th of octave model, and the enharmonic genus which may be represented by the system 1 1 5.

72 In his *book of cycles*, Urmawī takes the fifth (as was the case in Ancient Greek theory which inspired him) as a fourth to which a one-tone interval is added. With this concept of the scale, a fourth plus a fifth amounts to the same as combining two tetrachords (in fourth) and a one-tone interval in the frame of one octave, which, in Modal systematics, is equivalent to the combination of three intervals (among which two are equal) with a fixed sum.

73 *Urmawī's* concept is that there are two such intervals: the *comma* and the *limma*. In modern Arabian quarter-tone theory, these would be the quarter-tone and the semi-tone, respectively.

74 Differences of intonation may occur, but the interval remains conceptually the same.

75 Although some theoreticians may consider them as an exact expression of the size of the intervals.

76 As well as for an imposing other types of music.

77 Which may be combined in order to compose conceptual intervals.

78 The sizes of the greater and greatest tones in the 17-ET model suggest that the augmented second could be less, or greater than, the equal temperament tone and a half. The *ḥijāz* tetrachord (which today is usually made up of, in this order: one-semi-tone, one-tone-and a-half, and one-semi-tone) is not mentioned in *Urmawī's* list of tetrachords. This is very strange since this tetrachord is a combinatory variant of the old tonic chromatic Greek *genus* and commonly used in contemporary traditional music. Comparing sizes of the greater and greatest tones in the extended model, the difference between them would be one *comma*, which is the same difference existing between the *limma* and the smaller *mujannab* (or the equivalent of an *apotome*). However, the relative size of one *comma*, compared to one *limma* or one *apotome*, is very different from its relative size when compared to the greater and greatest tones. The difference, which is already difficult to hear between, for example, a double-*limma* and a Pythagorean tone (add one *comma* to the former to obtain the latter), would be even less distinguishable between the two larger intervals. On the other hand, *Urmawī* could not have used the *limma* between the greater and the greatest tones in order to differentiate them, as this would not have allowed for space, in the frame of a fourth, for two additional semi-tones (or *limmata*) in a tri-intervallic configuration (fig. 8, p174 – if we add one *limma* to the greater tone, the capacity of the greatest tone would have to be one *comma* plus four *limmata*. The capacity of the fourth in a Pythagorean 17 intervals model, is two *commata* plus five *limmata* – *i.e.*, a difference of one *comma* plus one *limma*. This leaves no space for the two additional *limmata*). This is possibly the reason why *Urmawī* gave up the *ḥijāz* tetrachord in its two (three) potential Pythagorean expressions, which would have been (a) M+Ts+S or a succession of one small *mujannab* (*limma* + *comma*, or *apotome*) plus one greater tone (tone + *limma*) plus one semi-tone (*limma*), (a') S+Ts+M'or a succession of one semi-tone plus one 'greater tone' plus one *mujannab*, and (b) the regular succession of one-semitone (*limma*), greatest tone (tone + small *mujannab* – or *apotome*) and one-semi-tone (*limma*) intervals (or L + greatest tone + L).

79 Used in the composition of other intervals.

80 Furthermore, that the numbers in the scale series express, before all, the quality of the intervals.

81 As a general remark on *Urmawī's* Pythagorean model, the sizes of neutral intervals, particularly in the *Book of cycles*, seem a bit far from their counterparts in music practice (and in *Fārābī* and *Sīnā's* theories). Owen Wright has explored this at length in his *The Modal system…* We have shown, however, that *Urmawi's* concept of the scale is not tonometric. It is qualitative. This is why the quantitative values of the intervals should not be taken into consideration for practice. Only their qualitative values should, of which the most important being the *mujannab* which lies somewhere (in size) in-between the one-*limma*

and the one-tone intervals.

82 Helmholtz, H., *On the Sensations of tone…* , p. 250.

83 Free Jazz or contemporary Western music break away from this principle and try to explore all the possibilities of sound. These attempts, although sometimes memorable, were never popular. It could be that music has an emotional power which may not exist with other forms of art, and that this emotion is induced by a process of reminiscence, predominant in music because of the long-term impossibility of recording it.

84 See Beyhom, A., *Étude comparée…* and *Des critères d'authenticité…*, notably, for the last reference (pp. 76-82), in connection with modal heterophony.

85 If intervals are not too small for reasons of clarity, or too large, there are no longer any scale, or any pattern for the melody.

86 The terms fourth, fifth and octave are in quotes because, in the statistical study, all possible compositions of these containing intervals are considered, *i.e.*, with more than, or less than, three (or four, or seven) conceptual intervals to a just fourth (or to a just fifth, or to an octave).

87 Turkish music and Byzantine chant follow roughly the same rules as Arabian music. They used the *maqām* as a *lingua franca*. The Turkish model is an extension of *Urmawī's* scale which might be better adapted to transpositions for the long necked *ṭunbūr*, and in the Chrysanthos of Maditos' version of 1818, Byzantine chant follows a 17-ET paradigm (extended as a measuring scale to the 68th of an octave, *i.e.*, by dividing the 17th of an octave in four equal parts – called minutes). In the 1881 Byzantine version of the *Commission of Constantinople*, a 24-ET model, had each quarter-tone being further divided in three equal measuring intervals (or a semi-tone equal temperament, with each of the semi-tones divided in six equal minutes, resulting in a 72-ET model). In both types, conceptual intervals remain equivalent to those in Arabian music, with the greatest conjunct tone, in the enharmonic *genus*, of Byzantine chant equivalent to the greatest tone in *Urmawī's* model. On the other hand, Ancient Indian music follows the same concept of interval quality because with the principle of 22 unequal *ṣrutis* the conceptual intervals are the result of a theoretical concatenation of smaller intervals, which are themselves elementary and auxiliary intervals. For an overview of the tonal systems of Indian music, see for example Powers, H. & Widdess, R., India, §3, 1, *The New Grove - Dictionary of Music and Musicians,* 12 (ed. Sadie S.), (Oxford, 2001), pp. 170-178. All these subdivisions of the scale, along with those of Javanese and other music, should be explored in detail in future publications.

88 *Maqām Ḥijāz-Kār* traditional beginning (and reference) note is *rāst*, commonly considered as equivalent to the Western note c.

89 This was mainly spread through the collective *Recueil des Travaux du Congrès de Musique Arabe qui s'est tenu au Caire en 1932* (Hég.1350), (Cairo, 1934), and Erlanger, R., *La musique arabe – Tome cinquième: Essai de codification des règles usuelles de la musique arabe moderne – Échelle générale des sons – Système modal*, (Paris, 1949).

90 For a detailed study of this problem, see Beyhom, A., *Systématique modale…*: www.beyhom.com/download/thesis/pdf/analyse_awj_ara. pdf. Furthermore, in a live performance, the author has heard only once in his lifetime an Arabian version of *maqām Awj-Āra*. This was played by a Moroccan lutenist named Saïd Chraïbi, in 2005. In a private conversation, the musician explained that he used the scale of *Awj-Āra* as given in Erlanger because he could not get a hold on a recorded Arabian version of this *maqām*. Chraïbi had already made at least two recordings including this *maqām*, which I later acquired under the titles *Souleïmane* and *Taquassim Aoud*, with no references or commercial identification.

91 This instrument is the main reference in both theory and practice for Arabian music and musicians. It is commonly tuned in ascending fourths with an additional (lowest) variably tuned string. This string is sometimes tuned to e- whilst performing *maqām Sīkā*.

92 The drones are sometimes used to accentuate the role of a structural note of a particular scale.

93 The tuning of the `ūd is difficult and time consuming. One musician has confided to the author and other participants, during a work

shop at Royaumont, and probably with some exaggeration, that he had probably spent half of his twenty years of professional career tuning the `ūd. See Beyhom, A., *Étude comparée…*

94 Mostly when coming back to the fundamental as a resting note.

95 Bearing in mind that the size of this interval may be, in performance, greater or lesser than the exact one-and-a-half-tones.

96 A scale element, here, is equivalent to a succession of conjunct intervals forming a containing interval. The minimal possible succession is made up of two intervals. The statistical study of the octave containing element (infra) shows sometimes the results for one single interval (NI = 1), to show symmetry with (NI = 12).

97 The full database of the hyper-systems, systems and sub-systems of the heptatonic scales in the quarter-tone model, with the limited alphabet of intervals, can be found in Appendix G, p. A35).

98 We shall use the terms fourth, fifth and octave henceforth, bearing in mind that the number of intervals in these containing intervals is variable, and represented by NI. The term just for each of these intervals is to be considered as an implicit quality.

99 These two intervals are taken as a successive one-tone and a one-and-a-half-tones.

100 This filter is one of the aesthetic criteria deduced from contemporary Arabian music and from *Urmawī's* model (which forbids two consecutive conceptual semi-tones). However, they do not necessarily apply, in the case of the fourth, to all modal music.

101 There must be no exception for the tetrachord 622 Erlanger recognises as *Sipahr* (see Erlanger, R., *La musique Arabe* – Tome 5…,p. 91). In his note to his first volume, p. 30, Erlanger says, that he felt this *genus* (which is the old tonic chromatic *genus* of Aristoxenus), should be included among other Arabian *genera*. In Volume 2 (Tome 2) of the same book (published in 1935), at p. 276, Erlanger (or Snoussi, his secretary, see Poché's introduction to the second edition of 2001) explains, nevertheless, that 'In *genera* theory, the most sensitive matter is the order in which the intervals decomposing the fourth in melodic sounds are placed, in relation to one another. With Arabian music, or at least in its urban form, that may be called classical, there is no occurence of two consecutive semi-tones in the same tetrachord...'

102 See Powers, H. (e.a.), 2001, Mode, *The New Grove -Dictionary of Music and Musicians,* vol.16, (ed. Sadie, S.), (London,2001), pp. 775-860, *sub* Mode, §V, 3: Middle East and Asia: *Rāga* – (ii) Modal entities and the general scale, p. 838: 'There are a few evident parallels between South Asian and West Asian orderings of modal complex and general scale. For instance, in both cases a given modal entity will use only some of whatever pitch positions an octave span of the general scale makes available – in principle seven – and normally no more than two intervals of the semi-tone class will occur in a succession in a single modal complex.'

103 In multiples of the quarter-tone. These are hyper-systems three and 4 (for NI=2) in figure 23, bottom.

104 Sub-systems having intervals larger than the largest conceptual second (the greatest tone – in both models taken as equal to one tone and a half) are marked with a postpositioned '§' and kept 'as is', even when the conjunct large intervals filter is applied. However, their number is shown for each case (for each value of NI) in the Conjunct big intervals row.

105 The smallest NI giving the lagest number of sub-systems, after eliminating sub-systems that do not comply with the aesthetic criteria listed in figure 23, 182.

106 This is equivalent to a generation with the limited alphabet of 1, 2, 3 in the semi-tone generation, and to 2, 3, 4, 5, 6 in the quarter-tone model.

107 The small conjunct different intervals criterion has no effect on the results of the semi-tonal generation.

108 This is because in order to generate redundant sub-systems, a system must contain a repetitive pattern, for example 112 (in the semi-tone multiples) in the 112112112 scale (an octave scale for which NI=9, and the sum of the conjunct intervals S=12) in the semi-tone model – there, of all the sub-systems generated by a de-ranking process,

only the first three are distinct. In other terms, and for a system to be able to generate redundant sub-systems, there must exist a suite of J integers repeated i times (this means that both i and J must necessarily be divisors of NI, as i x J =NI) in such a way that i x (ΣNj) = S (Nj is the size of an interval within a repetitive suite), in which i, j, Nj and S are integer numbers, with $1 \le i \le S$, $1 \le J \le S$, $1 \le j \le J$ and $1 \le \Sigma Nj \le S$, i and ΣNj being divisors of S, and i and J being divisors of NI. This formula is easily verified for the 112112112 scale above, as we repeat three (or i) times the suite of three (or J) intervals 112 whose sum ΣNj is equal to four, the whole of which verifies 3 x 4=12. However, if NI is equal to seven (if the scale be heptatonic), there simply exists no possibility of finding two integer numbers i and J which verify this formula, for both S=12 (semi-tone model) or S=24 (quarter-tone model), because NI is in this case a prime number that can be divided uniquely by itself or by one, and seven is not a divisor of twelve (of the sum S). In the case of the fourth in the quarter-tone model, and for NI=3, NI is once again a prime number that does not divide the sum S=10 (quarter-tones), neither does it divide S=5 (semi-tones). For the fifth, as is shown in figure 33, p. 189, the usual four intervals in the fifth generate independent (distinct) sub-systems only in the case of the semi-tone model, as NI=4 and S=7, and neither of the divisors of NI (i.e., the numbers 1, 2 and 4), except the trivial case 1, divides seven. In the quarter-tone model, however, S=14, and 2 divides fourteen so we may be able to find a suite of two (J) intervals repeated twice (i) systems provided that the sum of the two repeated intervals be equal to 14/2=7 (or S/i); this is verified for the suites 43 (or a one-tone interval followed by a three-quarter-tone interval) or 34 repeated twice, as is shown in Appendix B (see hyper-system N°7, system N°2, p. A12) to the present article.

109 We do not count here the non redundancy criterion, as this filter is self-evident.

110 See Mathiesen, Th., *Appolo's Lyre…*, p. 49: 'If the interval between the *lichanos* and the *hypate* is smaller than the interval between the *lichanos* and the *mese*, the smaller interval is called a *pycnon*...'; and Mathiesen's figure 51, p. 313. The author gives the *pycnon* a range of 5 quarter-tones, although this would apply to the low diatonic *genus* of Aristoxenus, and the *pycnon* would then be equal to its complement in the just fourth. The *genus* with the greatest *pycnon* with Aristoxenus is the whole-tone color, the tense chromatic *genus* in Mathiesen with a *pycnon* (composed of the smallest two intervals) equal to the one-tone interval, *i.e.*, smaller than its complement within a fourth. The smallest *pycnon* occurs, according to Aristoxenus, in the enharmonic *genus*, with a sum value of 2 quarter-tones.

111 Another possibility is that this was not accurately translated and explained until now.

112 This corresponds to a tree-like generative process with additional intervals chosen among the alphabet in order to comply with the homogeneity rule. Sums are checked afterwards to verify if the fifth is reached.

113 See Beyhom, A., *Systématique…*, Vol.3, pp. 7-13, and Appendix B – these pentachords are either rarely used, or are doubtful.

114 Most of these do not leave way for a possible combination of two tetrachords and a one-tone interval. The remaining set, *i.e.*, 3524262, 3434262, 2624253, 2624343 and 2624352, are probably in tune with the aesthetic criteria of Arabian music, but may be difficult to perform on the `ūd (for non-virtuoso performers) in its usual tuning (mainly in ascending fourths). See Beyhom, A., *Approche systématique…*.

115 Also to clarify the effect of each criterion on the outcome of the generative process.

116 See Barbera, A., *Arithmetic and Geometric Divisions* …p. 311.

117 The complete alphabet is, in multiples of the eighth of a tone, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, with the last value (16) representing the di-tone, which is the largest possible interval (in the frame of a fourth and with the semitone as smallest conceptual interval) in this model: for a complete listing of the results, see Appendix A.

118 The full results for the semi-tone model can be found in Appendix C.

119 The no conjunct semi-tones criterion applies to suites of

three or more semi-tones in a row.

120 Complete results in Appendices B and C.

121 Including redundant sub-systems in the optimal case for NI=4, which differs from all other above seen optimal cases.

122 Performers find it difficult to memorise more than a few dozens heptatonic scales, even when they are classified with the beginning genera and further combinations in Arabian theory. Modes may be taken as belonging to a family whose main characteristic is determined by the lowest tetrachord – this is a method which makes it easier to remember *maqāmāt*. However, this consists only of some 30 basic scale combinations. If such an arsenal is needed in order to memorise 30 scales, it seems clear that memorising 70 pentachords, with a subsequent and much greater number of octave scales, is simply an impossible task for the common musician.

123 This is a well known process in Ancient Greek and in Arabian theory. An example is given in details in Beyhom, A., *Systématique modale…*, pp. 301-312.

124 These intervals are too large, since they are greater than the one-and-a-half-tones interval and as such cannot be considered, ultimately, as conceptual intervals. However, the aim of the statistical study consists partly in determining the boundaries of the alphabet of these conceptual intervals.

125 The self-evident case for NI=1 appears only in this preliminary generative process.

126 As a general rule, scales with a NI as a prime number may not generate redundant sub-systems unless NI divides the sum of elementary elements within the scale (12 for the semi-tone model and 24 for the quarter-tone model. This is due to the characteristics of these numbers as explained in note N°108. For NI=2, with 2 being the second prime number (which divides itself and 1 only after 1 (NI=1 is a trivial case), two divides twelve and twenty four. As a consequence, there is a fully redundant system for NI=2, composed of two tri-tones (6 6 in semi-tones, or 12 12 in quarter-tones – for the latter, read twelve and twelve). The same applies for NI=3, 4 or 6, with hyper-systems 4 4 4, 3 3 3 3 and 2 2 2 2 2 2 in the semi-tone model.

127 Starting with these graphs, systematic comparison is undertaken between the two models (semi-tone and quarter-tone).

128 From this point on, only generations with a restricted alphabet are shown in the body of the article. For generations with the complete alphabets, with the exclusion of the one quarter-tone interval for the quarter-tone model, see Appendix E.

129 In the quarter-tone sub-system 3(244)362, for example, the fourth in second position (the 244 in brackets) is the first fourth of (244)3623, which is the next sub-system resulting from the deranking process.

130 This means that for each sub-system having a direct fifth, there is always a corresponding sub-system (which is obtained by de-ranking four times the initial sub-system with the direct fifth) with a direct fourth. In the previous sub-system (see note 129), the direct fourth is 244 with for complement 3623 fifth. De-ranking three times (*i.e.*, beginning with 2443623, 4436232, 436232, 3623244) we get a sub-system with a direct fifth 3623, but not necessarily a direct fourth. If we de-rank four times the last sub-system beginning with a direct fifth, we get the initial sub-system 2443623 with a direct fourth, but no direct fifth. Consequently, the number of sub-systems containing a direct fifth (in any of the generations shown) is equal to the number of sub-systems containing a direct fourth.

131 The extension from two to three semi-tones (in a row) in this filter allows for the existence of bi-fourth configurations (within a scale) with bordering semitones, for example two *ḥijāz* conjunct tetrachords – or (2 6 2) (2 6 2).

132 This filter is more permissive than the one used for the fourth and the fifth, due to the fact that some (very few, and mostly questionable) scales found in literature include conjunct one-tone and one-and-a-half-tones intervals – see Beyhom, A., *Systématique modale…*, Vol. III, notably pp. 33, 38 and 42.

133 I do not have yet a convincing explanation for this phenomenon, and this question remains open for further discussions.

134 The shape of the broken lines representing distributions of NS and NSSU_NR in figure 38 can be compared to a regular normal (law of) distribution in statistical studies, or bell-type distribution – the results do not correspond, however, to the analytical expression of that law.

135 See Appendix D for a full list of hyper-systems for this generation, together with the numbers of systems and sub-systems in each hyper-system.

136 For NI=8 (where as the first hyper-system is 1 1 1 1 1 1 1 5) we may not use intervals larger than the five semi-tones, whenever we may use intervals as large as the nine-semi-tones interval for NI=4 (where the first hyper-system is 1 1 1 9 – or three one-semi-tone and one nine-semi-tones adding up to 4 conceptual intervals the sum of which equals to twelve half-tones, or the octave).

137 This *lacuna* is due to my own limitations in statistical and mathematical sciences. Any explanation of the phenomena by a specialist in this field would be greatly appreciated.

138 Because NSS is, by definition, equal to NS x NI.

139 These redundant sub-systems are useless in the traditional concept of modal music.

140 The use of the Unitary Number of Non Redundant Sub-Systems in the previous generations for the fourth and the fifth would have emphasized the optimum at NI=3 for the fourth, and at NI=4 for the fifth. The lesser numbers of results for the previous generations have allowed us, however, to try to go deep inside the structure of the fourth and the fifth, without having recourse to the weighted variables used for the octave generations. In the latter case, it would be too long a task because of the very important numbers of sub-systems involved. See Beyhom, A., *Systématique modale…*.

141 In this system, three out of four sub-systems obtained by deranking are redundant. Consequently, this makes of it the unique sub-system.

142 With a limited alphabet, the two pentatonic hyper-systems come to 12333 and 22233 (see Appendix D). Only the last one allows for a simultaneous direct fourth and fifth configuration, or fourth in a fifth. In this case, the chosen alphabet can for example be extended to the di-tone (4), a step permitting the usage of four additional hyper-systems (namely 11244, 11334, 12234 and 22224), and multiplies by five the reservoir of systems (22224 is a poor candidate in this case as it generates one single system), and by four the reservoir of sub-systems which include a fourth in a fifth.

143 These results encourage questions about properties of numbers and their relations with the models in use.

144 Redundant sub-systems have a limited role in the quarter-tone model. Their weight in proportion to the total number of sub-systems is around 0,5%, whenever it is around 3% for the semi-tone model (with the exception for NI=12, with all sub-systems except that the original sub-system which is redundant). The qualitative results (optimal placements) are consequently not strongly affected by this criterion, in particular for the quarter-tone model, particularly for NI=7 (no redundancies).

145 The results in the following figures relate only to the restricted alphabet in order to give the most pertinent information. Graphic results for generations with the full alphabet are shown for both models, in Appendix E. Synoptical results for the quarter-tone model (full alphabet) are listed in Appendix F.

146 The full alphabet generation shows a maximal NSSU_NR value for N=6. All other optimal (NSS5U_NR and FFU_NR) occur for NI=7 – see Appendix E, figure A1, p. A28. In all the graphs, some of the results are corrected to the first decimal place.

147 The (almost, as the smallest interval is the semi-tone) full alphabet generation shows a steady optimal value for NI=7, shared in the case of FFU_NR with NI=8 – see Appendix E, figure A5, p. A30.

148 Semi-tones combine easily in the one-tone interval, as well as in the fourth or the fifth – see also figure 35 and section 'Discussing the preliminary results' above. 149 Ancient Arabian theory and practice seem to exclude these as well – other Ancient forms

of music must still be thoroughly checked for conformity with this criterion.

150 The full alphabet generation in semi-tones shows that optimal values occur for NI=6, except for NSSU_NR for which the optimal case is NI=5 (pentatonic scales) – see Appendix E, figure A3, p. A29.

151 The (almost) full alphabet generation in quarter-tones shows that the optimal values occur for for NI=7 for NSSU_NR, and NI=8 for the other variables – see Appendix E, figure A7, p. A31

152 With the quarter-tone model, sub-systems for NI greater than nine subsist principally because of the possibility to use the three quarter-tone interval in conjunction with the semi-tone (for example combinations such as 223, 232, and 223): these combinations were excluded for the generations in just fourth, notably with the Conjunct small intervals criterion or through the homogeneity rule.

153 All optimal values of the full alphabet generation in semi-tones occur for NI=7 – see Appendix E, figure A2, p. A28.

154 The almost full alphabet generation in quarter-tones shows optimal values for NI=7, except for FFU_NR (or DQQU_NR) with NI=8 – see Appendix E, figure A6, p. A30.

155 Beginning with NI=10, the largest interval is one single one-and-a-half-tones interval – see Appendix D for details about the internal structure of hyper-systems for these generations for the semi-tone model.

156 This filter excludes sub-systems containing sequences of three or more conjunct semi-tones as well as sub-systems with two conjunct intervals equal to or greater than 3 (semi-tones) or 6 (quarter-tones).

157 The full alphabet generation shows that optimal values occur for NI=6 – see Appendix E, figure A4, p. A29.

158 The almost full alphabet generation shows that all optimal values occur for NI=7 – see Appendix E, figure A8, p. A31.

159 Refining filters for the quarte-rtone model, for example, in order to verify better adequacy to the heptatonic model, setting the value of the largest interval of the alphabet to the 5 quarter-tones while testing for large conjunct intervals (this would tighten the results around NI=7), or by applying the conjunct small intervals criterion already used for generations within the 'one fourth' containing interval, or still by verifying the conformity of heptatonic sub-systems to the criteria of transitional two-interval semi-tones. This last one keeps only two-interval, and excludes three-interval conjunctions of semi-tones which occur on the transition from a fourth to a fifth, or from a fourth to another fourth, or from one octave to the other – see also the next note.

160 Other models include the 'lo-go' generations, with Lower than the Octave, or Greater than the Octave, sums for the sub-systems and models, etc. This can be equivalent to models of the octave in, for example, 23, 22, 21, or 25, 26, 27, etc. equal-temperament divisions of the octave). See Beyhom, A., *Systématique modale…* This generation confirms the adequacy of heptatonism in relation with the interval charateristics of modal music, notably in the domain of *maqām*.

161 Uncomposed within the containing interval, although measurable with the help of elementary, and measuring, intervals.

162 Notably acoustic.

163 Except for the quarter-tone model for the fifth containing interval, in which redundancies, although very limited, occur: we have seen that this model fits better the fourth containing interval, with the homogeneity rule leading to unique (non-redundant) *genera*, which represent all the common *genera* in Arabian music (the last one including all genera based on semi-tone classes of intervals).

164 Because of the possible disagreement between the harmonics which compose, in different proportions, their spectrum, or because of extra-musical reasons, sometimes linked to their numeric properties.

165 In the acoustic meaning.

166 If octave intervals were explored at that time.

167 The fourth or the fifth, for example.

168 In our geographical example: the particularities of the landscape.

169 One might decide to walk (or ride) through different villages.

170 It is not an exact temperament that is used by the performer.

171 Whenever we stop at a pitch other than the original beginning one, making the former, permanently or momentaneously, the basis for new developments of the melody.

172 Mainly in its improvisation form in the 20th century.

173 This state of balance is reached by the performer depending on his ability to (1) identify these slightly different intervals, and/or (2) reproduce them with his voice or his instrument.

174 For example *maqām Ṣabā* in Arabian music, the scale of which may be expressed as d e- f gb a' b'ᵇ c#; the upper octave is generally different from the lower one, and occurrences for d' are exceptional (commonly, the transition from the first to the second octave uses d'# e').

175 This explains why, as an aesthetic choice, performers who are well aware of the importance of the three consonant containing intervals may deliberately ignore them in order to obtain a different combination (such as avoiding the octave in *maqām Ṣabā* – see previous note).

176 For example: (1) use relatively large intervals within a containing interval, (2) avoid the consonances of fourth, fifth or the octave, (3) use a certain number of conjunct semi-tones in a row, etc.

177 Or whenever this simultaneous emission of more or less parallel melodic patterns was part of the local culture – the hypothesis developed in this paragraph does not necessarily apply to this type of music as for example the 'Are'Are music of the Solomon Islands, but may apply to improvised polyphonic music, in which the freedom of expression with the single performer is replaced by the freedom of vertical improvisation within a party of musicians. The hypothesis is that, even in the latter case, a preliminary process of scale calibration, as the one explained in the text above, is at the origin of heptatonic scales (if used in that particular music).

178 Octatonic or enneatonic scales found in some literature may also be the result of the inclusion of modulation variants for a scale, or for part of it, at least in musical theory.